DEPARTMENT OF THE INTERIOR, CANADA
Hon. ARTHUR MEIGHEN, Minister; W. W. CORY, Deputy Minister
Reclamation Service—E. F. DRAKE, Director

ANNUAL REPORT

OF THE

RECLAMATION SERVICE

1919-20

OTTAWA
THOMAS MULVEY
PRINTER TO THE KING'S MOST EXCELLENT MAJESTY
1920

Mount Temple.
(The source of water supply).

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TABLE OF CONTENTS

TABLE OF CONTENTS.—*Continued*

PLANS

RECLAMATION

REPORT OF THE DIRECTOR OF THE RECLAMATION SERVICE.

E. F. DRAKE.

Reference was made in the report for last year to the sudden and widespread awakening of interest in irrigation throughout Southern Alberta and Southwestern Saskatchewan, and to the probability of another dry season, with practically complete crop failure, which would aggravate a condition even then very serious.

The event has proved even worse than the prediction. The year 1915 will long be remembered as the "year of the bumper crop." The following year was almost as good, while the yield was not as great, it was above average and the high prices made the crop almost as profitable as—in some cases more so than—that of the preceding year. But 1918 was a notably dry year with serious crop failure throughout the "dry belt," and drew heavily upon the scanty reserves of stored moisture in the soil. The season of 1919 was even drier than the two preceding years and as the reserves of moisture were largely exhausted, practically no crops were prduced in the "dry belt," except where irrigation was practised.

In the following table, which is now published for the third consecutive year, an attempt is made to show the relationship between rainfall and the yield of the principal cereal crops, taking into account as well the prices obtainable for the crops, so as to indicate in a general way the gross profit of each crop to the producer. But, while the table clearly enough indicates a definite relationship between rainfall and crop production, there are other important factors to be considered, such as rust, which seriously reduced the yield of wheat in Saskatchewan in 1916; the disastrous frost of July 25, 1918, in Northern and Central Alberta and Saskatchewan; local losses from hail and from soil-blowing, etc.

But the most serious defect in the table is that, while it gives an accurate record of rainfall during the growing season at selected typical points, it shows the crop yield per acre for the entire province instead of for a limited district comparable with that for which the rainfall is given. It has been impossible heretofore to procure accurate crop statistics for such limited areas, although it is hoped that arrangements to do this can be made before long. The net result, therefore, is that the effects of scanty rainfall are not as forcibly indicated as would be the case if the rainfall and crop records were *both* limited to the drier districts.

The following tables are based upon the best information obtainable. The "normal prices" are estimated, and are possibly rather high, but accurate information of average prices in past years is not readily obtainable.

TABLE SHOWING YIELD OF WHEAT, OATS AND BARLEY, FOR THE YEARS 1915–16–17–18–19.

Alberta

Crop and Year.	Yield per Acre.	Average price per Bushel.	Average price per acre.		Yield per acre.	Rainfall at Calgary, April to August.	
Wheat—	Bush.	$	$	%	%	Inches.	%
Normal	22·50[1]	1·00[2]	22·50	100	100	11·56[3]	100
1915	31·12	·88	27·39	122	138	12·27	106
1916	24·99	1·33	33·24	148	111	8·93	77
1917	18·25	1·74	31·73	141	86	6·63	57
1918	6·00	1·92	11·71	52	27[4]	5·78	50
1919	8·00	1·83	14·80	65	36	7·49	65
Oats—							
Normal	42·00[1]	·34[2]	14·28	100	100		
1915	45·91	·31	13·97	101	109		
1916	48·11	·46	22·13	155	115		
1917	34·00	·63	21·42	150	81		
1918	22·75	·73	16·61	116	54		
1919	23·75	·64	15·20	106	54		
Barley—							
Normal	28·25	·50[2]	14·12	100	100		
1915	32·31	·44	14·27	101	114		
1916	29·04	·71	20·62	146	103		
1917	22·00	·98	21·56	153	78		
1918	16·50	·97	16·00	113	58		
1919	25·50	1·86	47·43	336	89		

[1]Average for 10 years, 1908–1917. [2]Estimated. [3]Average for 30 years 1885–1914. [4]Results affected by frost 25th July, 1918.

TABLE SHOWING YIELD OF WHEAT, OATS AND BARLEY, FOR THE YEARS 1915–16–17–18–19.

Saskatchewan

Crop and Year.	Yield per acre.	Average Price per Bushel.	Average price per acre.		Yield per acre.	Rainfall at Swift Current, April to August.	
	Bush.	$	$	%	%	Inches.	%
Wheat—							
Normal	18·50[1]	1·00[2]	18·50	100	100	10·03[3]	100
1915	25·12	·91	22·86	124	136	10·14	101
1916	16·34	1·28	20·92	113	88[4]	14·09	141
1917	14·25	1·95	27·79	150	77	5·12	51
1918	10·00	1·99	20·00	108	54[5]	5·62	56
1919	8·50	1·84	15·64	85	46	7·38	74
Oats—							
Normal	38·25[1]	·34[2]	13·00	100	100		
1915	43·48	·32	13·72	106	114		
1916	43·06	·46	19·81	152	113		
1917	27·25	·62	16·90	130	71		
1918	21·50	·70	15·05	116	56		
1919	23·10	·70	16·23	125	63		
Barley—							
Normal	26·75[1]	·50[2]	13·38	100	100		
1915	31·74	·46	14·64	109	119		
1916	27·00	·77	20·79	155	101		
1917	21·00	1·00	21·43	157	79		
1918	17·00	·88	14·96	112	67		
1919	18·20	1·08	19·66	147	22		

[1]Average for 10 years, 1908–1917. [2]Estimated. [3]Average for 30 years, 1885–1914. [4]Results affected by rust. [5]Results affected by frost 25th July, 1918.

IRRIGATION DEVELOPMENT

Three successive dry years have thoroughly awakened the settlers in the "dry belt" to the necessity of irrigating every acre of land to which water can be brought at reasonable cost. Even the advocates of dry farming now admit that their methods of tillage invite disaster scarcely less serious than drought itself. The success of dry farming as now practised depends primarily upon a system of summer-fallowing and frequent stirring of the surface so as to produce a mulch or blanket of fine soil particles which will prevent losses of moisture by capillarity. But this constant cultivation soon pulverizes the fine soil of the dry belt to a light powder which the frequent high winds blow about at will, either burying the seed or young crop or blowing them out entirely.

Irrigation, with greater variety of crops and with the radically different methods of tillage which necessarily accompany it, is at once the cure for soil-blowing as well as for drought, and there is now a widespread and insistent demand that its benefits be extended wherever possible.

The Dominion Government has always recognized its responsibility for making at least preliminary surveys in order to indicate how, and where, the available water supply, which it holds in trust and administers, may be utilized to the best advantage. It soon became apparent, however, with the awakened interest in irrigation development, that demand would be made that the Dominion should not only make complete surveys, including the location and design of works, but that it should also either construct the required works or materially assist in financing such construction, notwithstanding that the organization of irrigation districts, the raising of money by bond issues with the land as security and the actual operation and maintenance of works constructed on the co-operative plan, are all governed by provincial rather than by federal laws, and that these laws were enacted by the Provincial Government upon the insistent request of the settlers themselves.

As the situation developed early in 1919 the Minister of the Interior considered it desirable that there should be a clearer understanding as to the division of responsibility between the Dominion and Provincial Governments. He therefore took the question up with the Government of Alberta and pointed out that the Dominion was being pressed from time to time to make surveys in different districts, involving in each case considerable expenditure; that these requests were at times accompanied by very direct intimation that the Dominion would be expected to assist in the further prosecution of the enterprises, and that there was seeming reluctance on the part of the provincial authorities to disassociate themselves from these intimations; that no appreciable area of the land requiring irrigation is owned by the Dominion; and that while the Dominion exercises general control over surface water the Irrigation Act and Regulations are quite adaptable to the carrying on of such development by districts or by the provincial authorities. The minister was therefore of opinion that, before committing his department, and the Dominion Government, to further and large expenditures for irrigation and survey work, there should be a clear understanding that the responsibility for anything in the way of development beyond the survey work is not a federal responsibility, unless in any specific case Dominion lands are to a substantial extent to be benefited.

The minister did not ask that this responsibility be assumed by the province; in fact he stated explicitly that, so far as he was concerned, the Provincial Government was quite at liberty to reserve to itself the utmost freedom in so far as its commitment to the development of irrigation problems is concerned. But the minister did ask for a definite acknowledgment by the Provincial Government that the Dominion's responsibility towards irrigation should not extend beyond the survey work and general engineering assistance and supervision which he was ready to undertake, and he made it clear that unless he received such assurance he could not authorize the further survey work which he was being pressed to undertake.

In the ensuing correspondence it was definitely stated that the Dominion Government could not assume any responsibility for actual irrigation development beyond the survey work and such supervision as had theretofore been given and would be continued. The Provincial Government finally acquiesced in this statement of the division of responsibility between the Dominion, on the one hand, and the provincial or local authorities, on the other.

Immediately such understanding was reached, the minister authorized the resumption of survey work.

Surveys had been begun in 1914 for the purpose of determining the location and area of land irrigable from the available sources of water supply in Southern Alberta, but this work was interrupted by the war and was not resumed until about July, 1919. Enough information was obtained from the surveys of 1914 and 1915 to roughly define several large tracts of irrigable land and to indicate, more or less definitely, how water could be brought to them. When field-work was resumed in 1919 it was decided to make complete plane-table surveys of the irrigable tracts previously located and at the same time to make a thorough study of the water supply, with a view to the conservation of as much as possible of the flood water that has heretofore gone to waste. This necessitated a further study of possible canal locations and in some cases entirely new location surveys.

A brief, general description of this work will be found in the report of the Commissioner of Irrigation, which is submitted herewith. The work was not begun until about July 1, and considerable difficulty was found in securing a sufficient number of engineers familiar with such work; consequently it was not found possible to complete even the programme of work laid out for the season. Provision has, however, been made for completing the work during the season of 1920.

The principal deterrent to further irrigation development is the difficulty of financing. The money for the construction of new works must be raised by bonds secured upon the land and irrigation bonds are not readily saleable at anything like par value. Notwithstanding that irrigated land in Southern Alberta and Saskatchewan is worth, at a conservative estimate, from twice to three times the price of dry land, investors are apparently not willing to risk the successful construction and operation of co-operative irrigation projects. Definite proof is readily available that irrigated land in the Lethbridge district has, through a long period of years, produced at least double the crop raised on dry land. The water supply for any of the projects now mooted is assured; the most careful supervision of the design and construction of works will be given by the Dominion Government; the Provincial Government will unquestionably exercise equally strict supervision over the construction expenditures and will lend its assistance in collecting the principal and interest payments year by year as they fall due. But notwithstanding all this investors fight shy of irrigation bonds

The only practicable solution of the problem seemingly is the purchase of the bonds either by the Provincial or Dominion Government, but this is a question of policy that must be decided by the Governments, and its further discussion in this report would be inappropriate. It is to be hoped, however, that some solution of the problem will be found quickly.

DRAINAGE

Although land drainage on a large scale was not undertaken by the Reclamation Service until the spring of 1919 the work has already developed beyond expectation. Great interest is being shown by small landowners in the drainage of shallow lakes or swamps, and many projects of this kind have already been authorized, while the number of applications received has severely taxed the resources of the engineering staff available for inspection work.

By co-operative arrangements between the Dominion and Provincial Governments, bona fide settlers are encouraged to purchase swampy or submerged lands at

a merely nominal price, and subject only to the conditions that adequate drainage works be constructed and thereafter maintained in serviceable condition. This is regarded as good business policy as such lands are, in their present condition, worthless and non-productive, and considerable areas of such land in any district materially retard its development. No such sale is authorized where the area to be reclaimed exceeds 1,280 acres, or the cost of the drainage works is more than $5,000.

Larger areas may also be reclaimed by drainage under co-operative arrangements between the Dominion and the provinces, and several drainage districts have already been organized in both Alberta and Saskatchewan, and works are under construction in some of these. Money for construction purposes is raised by bonds secured upon the lands and no serious difficulty has so far been experienced in selling drainage bonds at fair prices.

In still other cases, where the Dominion Government owns the bulk of the land, surveys are made and actual construction may be undertaken by the Dominion and the cost recovered by the sale of the reclaimed land. Several promising projects of this kind have already been investigated and in one case—Waterhen lake in Northeastern Saskatchewan—surveys have been completed, a drainage district has been organized under provincial laws, and, as this report is written, tenders are being asked for the construction of the works. Should this project prove successful, two or three other large projects are ready for development as soon as funds are made available.

Notwithstanding the necessity for economy in the expenditure of public money, it may be confidently asserted that large expenditures on drainage work are amply justified. Large areas of practically worthless land require reclamation. In its present condition this land breeds mosquitoes, makes travel difficult, retards the development of other land in the district, and produces nothing of value. When drained it becomes good farm land, or in some cases hay and pasture land, makes good roads possible, increases settlement, and its sale after reclamation will return to the Dominion treasury at least the cost of its reclamation and in most cases much more. It is therefore sound policy that these land assets, which are now unproductive, or worse, should be reclaimed, particularly when such reclamation can be made to pay for itself.

There are submitted herewith brief reports by Mr. F. H. Peters, Commissioner of Irrigation and Chief Engineer, on the work of the Irrigation Division of the Reclamation Service, and by Mr. R. J. Burley, Assistant Director and Chief Engineer of the Drainage Division, on the work of that division.

REPORT ON IRRIGATION SURVEYS AND INSPECTIONS

By F. H. Peters, *Commissioner of Irrigation and Chief Engineer*

Similarly to last year, in an endeavour to condense the rapport as much as possible and submit only such matter as is necessary for record, all the subject-matter has been dealt with in one summary report. No original reports are submitted, but as a matter of record the names of all engineers in charge of any important part of the work have been mentioned. All efforts to prepare the report in an attractive form have been sacrificed to the direct scheduling of the more important features of the work in brief form.

All original reports and data are filed at Calgary and Ottawa and in so far as possible the complete information will be made available to persons who are particularly interested in any special feature of the work.

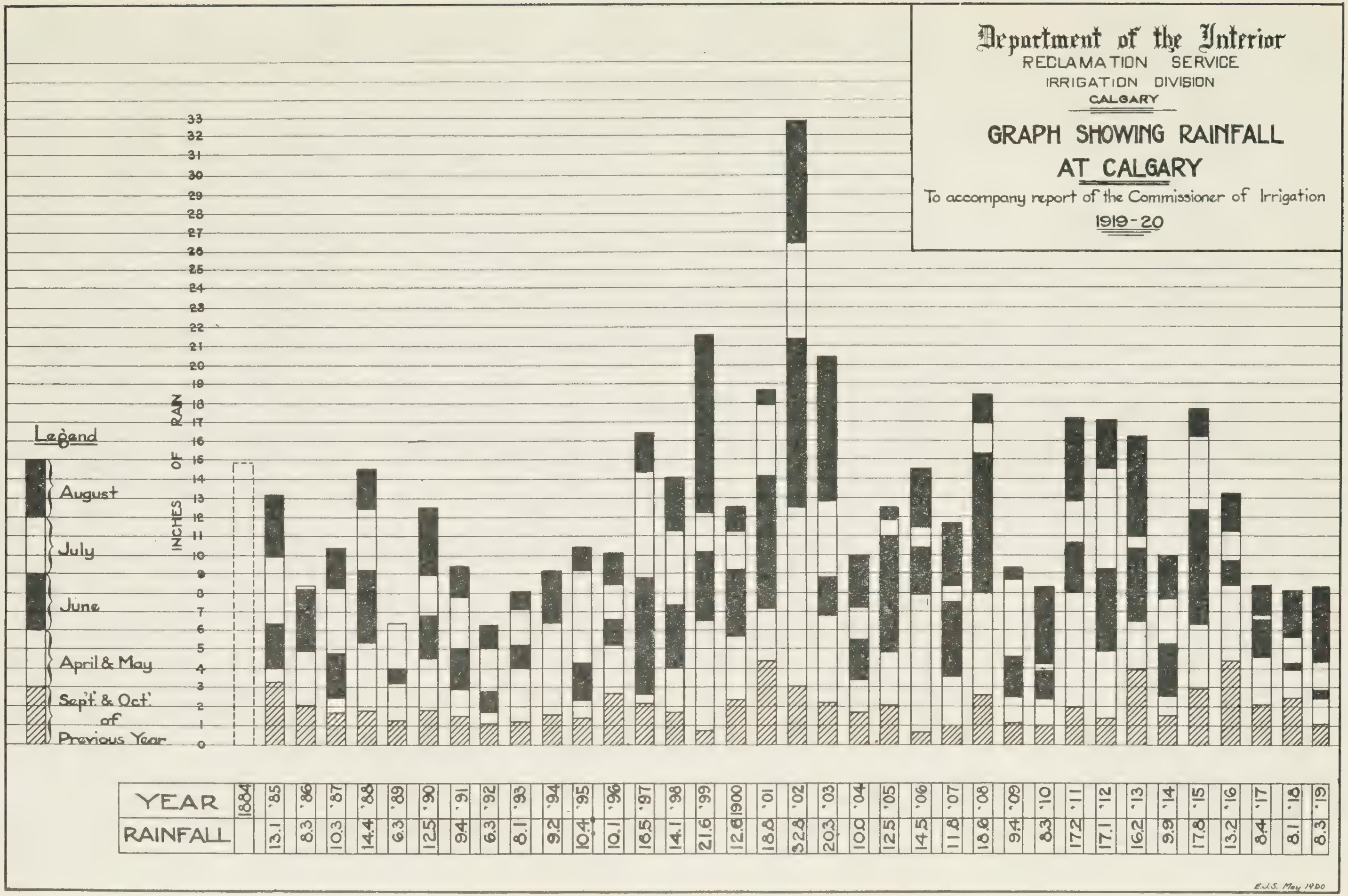
GENERAL

As was indicated in last year's report, due to the succession of two dry years, 1917 and 1918, a very strong movement developed in the south country during the winter of 1918-19 in favour of irrigation development. The year of 1919 was almost as dry as 1918, with the result that the people in Southern Alberta—both farmers and business men—have at last become generally convinced of the great desirability, if not necessity, of irrigating every possible acre in the southern districts.

As a result very strong demands arose for the completion of the surveys of all the large projects which have been contemplated and in addition a very large number of applications were received during the year from persons who wanted to construct small private irrigation schemes. It was not found possible to complete either all the large survey work required, or the necessary inspection of the small private schemes. It is consequently expected that a very heavy programme of work will have to be undertaken in both these departments during 1920.

The "Graph Showing Rainfall at Calgary" is being published with a view to indicating the very dry period which was experienced during 1917, 1918 and 1919. The graph shows that the driest period ever recorded at Calgary was from 1891 to 1896, and that since that time there has been no protracted period of drought so severe as the one just experienced. This graph has been prepared with a view to showing typical conditions for Southern Alberta as regards rainfall in relation to crop growth. It is assumed that the precipitation for November to March in each year falls as snow and is of practically no value for crop, being either dissipated by chinook winds or running off into the streams on top of the frozen ground. The useful rain in growing any year's crop is assumed to be the rainfall of that year from April to August plus the amount which has been stored in the ground from September and October of the previous year. It may be taken as a general rule that when the columns in the graph are less than ten inches high all grain crops have suffered from drought, unless the preceding year was very wet, in which case a lot of water would remain stored up in the soil over the winter.

The most striking feature of the graph is the very marked ups and downs which is considered to indicate very clearly the conditions which have been met and will be met in Southern Alberta in carrying on agricultural operations without the aid of irrigation.


Department of the Interior
RECLAMATION SERVICE
IRRIGATION DIVISION
CALGARY
GRAPH SHOWING RAINFALL
AT CALGARY
To accompany report of the Commissioner of Irrigation
1919-20
Legend
August
July
June
April & May
Sept. & Oct. of Previous Year
INCHES OF RAIN
YEAR 1884 '85 '86 '87 '88 '89 '90 '91 '92 '93 '94 '95 '96 '97 '98 '99 1900 '01 '02 '03 '04 '05 '06 '07 '08 '09 '10 '11 '12 '13 '14 '15 '16 '17 '18 '19
RAINFALL 13.1 8.3 10.3 14.4 6.3 12.5 9.4 6.3 8.1 9.2 10.4 10.1 16.5 14.1 21.6 12.6 18.8 32.8 20.3 10.0 12.5 14.5 11.8 18.8 9.4 8.3 17.2 17.1 16.2 9.9 17.8 13.2 8.4 8.1 8.3
E.J.S. May 1920

ORGANIZATION OF STAFF

The organization of the staff was similar to that of last year but the volume of survey and inspection work was greatly increased.

During the year practically all of the permanent employees who had been away during the past years on active service returned and were absorbed into the staff again.

An appreciable number of permanent employees were lost during the year, these being drawn away by the considerably higher remuneration offered by private corporations. There has been great dissatisfaction throughout all of the permanent staff due to the failure to put the Civil Service reclassification into effect as promised.

Because of the unsettled state of affairs during the year and the great difficulty in getting appointments made quickly under the regulations now in effect, the Hydrometric Branch was undermanned during the whole of the year.

STREAM ADMINISTRATION

In the early stages of irrigation development it was chiefly necessary to consider the local water supply in each case, but, as the demand for water increased, it became essential to take a broader view of the situation. It is now the practice to ascertain the effect of all new schemes upon the watershed to which any source of supply is tributary.

In 1915 a system was designed with a view to replacing the old records of applications by books prepared according to more complete and suitable water accounting methods. These indicate the priority of all applications, as required by the Irrigation Act, as well as the quantities of water, in terms appropriate to modern irrigation practice. The Act provides for the use of water for municipal, industrial, domestic, irrigation, and other purposes.

The gradual revision of the records of all these water rights in Alberta and Saskatchewan has now made substantial progress.

The Irrigation Act includes provision for the recognition of three stages or periods, during which water may be diverted according to priority, viz., low, high and flood, but the method of determination of stages is not defined. Regulation number seventeen prescribed under the provisions of the Irrigation Act in 1919 deals with this point upon the principle of "duration of flow," involving mathematical calculations and graphic studies based largely on the information secured by the Hydrometric Division during the past twelve years, supported by the valuable precipitation records of the Meteorological Service extending over some thirty-six years for the principal stations. The duty of water prescribed by the Act has been amended to provide for a more extensive use of water for irrigation purposes.

It has always been the practice of the department to limit the grants to the quantity of water believed to be available under average conditions, but, as the demand increases, it is necessary to study the conditions in greater detail to ensure that all water is applied to beneficial use. The conservation of flood waters is a question of special importance which will become more pressing as the value of irrigated lands increases.

The ultimate intention is to revise all old licenses to conform to the new regulations prescribed by the Minister of the Interior in February, 1919. In the case of new licenses and transfers these regulations are already being applied.

Bow River, 187; Oldman River, 350; Red Deer River, 87; South Saskatchewan have been divided into drainage basins. The principal drainage basins with the number of recorded applications in each are scheduled hereunder:—

Bow River, 187; Oldman Rover, 350; Red Deer River, 87; South Saskatchewan River, 103; North Saskatchewan River, 88; Milk River, 27; Cyress Hills (Group), 728; Qu'Appelle River, 179; miscellaneous, 257.

The total number of recorded applications distributed as above is 2,006.

A large percentage of these applications requires individual investigation to determine their standing and possibilities with regard to water supply, as well as their effect upon future development. Many questions of policy and principle have been decided in correspondence with the director. All records are duplicated for reference at Ottawa and are being checked in both offices to ensure accuracy and consistency.

Recent experience indicates that the conditions of supply are critical at certain periods in several of the Cypress Hills drainage basins, and a water-master has been appointed to regulate diversion in these areas. For satisfactory administration, and in order to avoid future disputes and litigation, it is essential that all water rights be clearly defined.

Since September, 1919, Mr. J. A. Spreckley, acting as water administration engineer, has been in charge of this work.

HYDROMETRIC SURVEYS

TABLE No. 1.—RUN-OFF IN ACRE-FEET ON STREAMS IN ALBERTA AND SASKATCHEWAN

Station.	Up to September 30, 1918.					1918-19.
	Maximum.	Year.	Minimum.	Year.	Average Year	
Athabaska River at Jasper	2,609,949	1914-15	2,177,939	1916-17	2,362,489	2,206,210
McLeod River near Thornton	1,395,298	1914-15	837,968	1915-16	1,067,823	459,525
Athabaska River at Athabaska	12,177,223	1914-15	9,480,831	1917-18	10,498,408	7,500,856
N. Saskatchewan River near Rocky Mountain House	5,132,546	1914-15	3,136,982	1913-14	4,004,047	2,864,538
N. Saskatchewan River at Prince Albert	9,943,435	1914-15	5,329,986	1917-18	7,923,468	4,243,396
Red Deer River at Red Deer	3,069,743	1914-15	851,101	1913-14	1,973,652	763,459
Bow River at Banff	1,192,250	1910-11	987,664	1916-17	1,095.858	948,116
" Calgary	3,650,670	1914-15	2,552,537	1913-14	2,872.011	2,103,022
Elbow River at Calgary	537,890	1915-16	189,508	1917-18	329,681	181,415
Sheep River near Okotoks	593,873x	1914-15	69,341x	1909-10	267,519x	98,616x
Highwood River near Aldersyde	714,552x	1915-16	226,939x	1913-14	432,722x	199,542x
Nanton Creek near Nanton	13,721x	1915	385x	1910	5,875x	237x
Mosquito Creek near Nanton	53,224x	1917	1,726x	1910	21,528x	1,729x
Crowsnest River near Lundbreck	253,953	1915-16	157,028	1913-14	193,469	146,150
Castle River near Cowley	655,596	1915-16	395,357	1917-18	496.358	298,092
Oldman River near Cowley	653,725	1915-16	271,470	1917-18	437,223	266,297
" near Macleod	1,825,854	1915-16	808,947	1917-18	1,256,825	704,638
Waterton River near Waterton Pk.	631,163	1915-16	385,451	1917-18	487,157	338,546
Belly River near Standoff	387,448	1915-16	212,155	1917-18	290,168	171,101
Lee Creek at Layton's Ranch	88,986	1915-16	25,944	1917-18	53,950	12,769
Manyberries Ck at Yeast's Ranch	16,639x	1916	3,676x	1914	8,840x	3,591x
Lodge Creek at International Bdy.	76,526x	1912	12,599x	1914	43,676x	7,897x
Battle Creek at Ten Mile	51,701x	1916	13,780x	1914	31,981x	5,913x
" at Nash's Ranch	93,375x	1916	12,830x	1914	44,227x	5,378x
Frenchman River at East End	130,463x	1917	24,321x	1914	52,522x	16,390x
Bear Creek at Unsworth's Ranch	20,025x	1917	2,569x	1910	11,046x	4,036x
Maple Creek near Maple Creek	15,384x	1917	2,348x	1918	6,173x	513x
Boulder Creek at Young's Ranch	10,997x	1917	602x	1913	3,958x	167x
Bridge Creek at Gull Lake	9,572x	1917	129x	1914	3,790x	186x
Swift Current Creek near Swift Current	121,323	1916-17	41,690	1914-15	79,232	22,780
Moosejaw Ck. at McCarthy's Farm.	100,730	1915-16	304	1914-15	31,438	11,570
Peace River at Peace River	45,207,069	1917-18	35,189,992	1916-17	40,875,425	44,340,630
Smoky River at Smoky	9,330,403	1915-16	7,822,198	1916-17	8,756,633	7,425,556

NOTE.—x Open-water season records only. Records not marked x are for climatic year which ends September 30.

Mr. A. L. Ford, who succeeded Mr. P. M. Sauder as chief hydrometric engineer on January 1, 1920, has submitted the following brief report indicating the scope of this part of the work:—

"The drought of 1919, following the dry years of 1917 and 1918, has very strongly emphasized the importance of procuring records of stream flow for a long period of years so as to obtain the range of flow. At stations established throughout the length and breadth of the provinces of Alberta and Saskatchewan the records show that the total discharge for the past year is, in almost all cases, the lowest for any year since the inception of the Survey in 1909, although no doubt the discharge was just as low or lower during the long drought periods before that time. This fact is shown by a

study of table No. 1, giving a comparison of records of total flow for typical stations throughout the two provinces, covering all records obtained at these special stations up to September 30, 1919. Hydrometric records are kept throughout Canada on the climatic year basis, the climatic year commencing October 1, and ending September 30, the following year.

"Following the drought during the open-water period came an early freeze-up. The winter period was therefore entered upon with a low ground water-level. Many of the streams which usually have an increased flow in the fall were dry at freeze-up and remained so throughout the winter. While there was, generally speaking, a heavy snowfall during the winter, this extra precipitation has been used up in raising the ground water to normal level or has been carried off by evaporation during periods of chinook winds.

"The past year has seen a great increase in proposed irrigation development. The records of stream flow have been called upon very frequently to determine the feasibility of schemes and in many cases to determine irrigable areas. The records of minimum flow obtained during the past climatic year are, therefore, proving of exceptional value at the present time.

"In order to provide data on small streams where irrigation projects depend on impounding the early spring floods in reservoirs, a special effort was made to get the engineers into the Cypress Hills country before the first week in March. This was accomplished with satisfactory results.

"The flood prediction survey on the head-waters of the Bow River drainage basin, which was started in 1916, was continued in May and June and it was found that there was not likely to be any danger of floods from snow-water. This prediction was justified by the event.

"There are two peaks of field-work for the Hydrometric Survey during the year, one during the spring break-up, which was met successfully as stated above, and the second during the high water in June and July. During 1919 this secondary peak was not of any importance, but the call during 1919 for records of floods in order to design headworks for irrigation projects emphasizes the necessity of obtaining records of flood periods whenever met with, so that there may be on hand the best possible maximum flow records when such data are needed.

"During the year the Drainage Division of the Reclamation Service was formed to attend to the demand for drainage of large areas in the northern portions of Alberta and Saskatchewan. In order to provide the fundamental data for this work the Hydrometric Survey has been called upon to establish a number of stations on lakes, and on the streams running into and out of them, in the territory affected. Speaking generally, high water-level records of lakes, etc., are of more value from the drainage point of view than low water records such as were obtained in 1919, but for drainage as well as irrigation work the range of stage is important, and the 1919 records are doubtless very close to the lowest stage.

"While water-power development is not very active in Alberta and Saskatchewan at the present time, records of winter flow during the present period of very low flow will prove at some future date very valuable in determining the feasibility of many proposed power projects.

"The Survey acted in conjunction with the Montana Division of the United States Geological Survey in obtaining the flow of international streams in the St. Mary River and Milk River drainage basins. This information was used by representatives of the Reclamation Services of the United States and of Canada as basic data in the division between the two countries of the waters of the St. Mary and Milk rivers.

"In connection with this work a question arose as to the accuracy of the rating of a meter which had been rated at the rating station at Calgary. This meter was re-rated at our station and then sent to the Bureau of Standards, Washington, D.C. It is pleasing to note that their rating was identical with ours.

"During the year sixty current-meters were rated, ten belonging to the British Columbia Hydrometric Surveys, three to the Manitoba Hydrometric Surveys, five to the Ontario Hydro-Electric Power Commission, four to the Canadian Pacific Railway Company, two to the United States Department of Agriculture, and the balance, thirty-six, to this office.

"The field-work was carried on throughout the year in spite of the difficulty met with in obtaining and keeping the services of engineers due to the low remuneration offered. The office work, however, had to be sacrificed to the field work, and has, therefore, fallen behind. The difficulty of keeping up the staff is shown by the fact that to maintain an establishment of some twenty engineers, thirty-two were employed at one time and another during the year without succeeding in keeping the staff up to full strength throughout the year.

"During the open-water period, records were taken at one hundred and fifty-seven regular gauging stations on streams of Alberta and Saskatchewan, at about one hundred and seventy-five gauging stations on irrigation ditches and canals and at twenty-eight stations on lakes. Winter records were taken at eighty-eight stations on streams during the past winter.

"The annual reports of the Hydrometric Survey, giving information as to run-off at the special stations in the provinces of Alberta and Saskatchewan for the climatic years which ended on September 30, 1917, and September 30, 1918, were published during the year. Copies of these reports can be obtained from the Director of the Reclamation Service at Ottawa, or the Commissioner of Irrigation at Calgary. For the purpose of economy in printing these reports, considerable data formerly published have been left out. Any one wishing to obtain these additional data should make a written request of the Commissioner of Irrigation stating the particular data required."

IRRIGATION DISTRICTS ACTS

The first irrigation district law affecting what are now the provinces of Alberta and Saskatchewan was passed by the old Territorial Government in 1898 and was known as *The Irrigation District Ordinance No. 30.* This Ordinance was amended in 1903. In 1915 the Alberta Legislature passed *The Irrigation Districts Act,* which repealed the old ordinance. This Act was amended in 1919. In 1920 a new *Irrigation Districts Act* was passed which repealed the Act of 1915. This new Act, which received a great deal of attention in the legislature, contains a large amount of new or changed matter, and is considered in its new form to be a great improvement on the old Act.

The old Alberta Act contained provisions for the formation of *Water Users Districts* which in practically all respects were similar to those for the *Irrigation District* but which were considered too cumbersome for the smaller organization. The new Act refers only to the *Irrigation District* and a separate Act providing for the formation of *Water Users Districts* has been passed.

The old *Irrigation District Ordinance* was repealed in Saskatchewan some time ago. The last Legislative Assembly of Saskatchewan passed the *Irrigation Districts Act,* 1920, which is similar to the last Act passed in Alberta.

FIELD-WORK

Domestic Water Supply.—In the report for 1917-18 reference was made to the very difficult conditions affecting water supply for domestic, municipal and industrial purposes over a large area of the drier parts of Alberta and Saskatchewan. While the effort to collect data for the betterment of this condition was maintained during the year, little progress was made because this work had to give way to other work of more pressing nature, mainly in connection with inspecting new applications for water rights. The work will be continued next year.

During the three years 1917 to 1919 reports to the number of fifty-three, twelve and three, respectively, have been submitted concerning small domestic water supplies. During the same period reports to the number of two hundred and ninety-one, two hundred and forty-five and thirteen, respectively, have been submitted giving data regarding wells. These latter include a number of reports on artesian wells and reports kindly submitted to us by persons and organizations interested in the development of the country.

Artesian Wells.—In following up the development of the artesian well area in Southern Alberta samples of water were obtained from six artesian wells and submitted to the Dominion Chemist for analysis. As this general subject is a matter of considerable interest in the south country, the results of these tests are quoted in part hereunder:—

"Beaver well, in section 24-2-11, depth, 165 feet; Government well No. 3, in section 19-4-8, depth, 643 feet; town of Foremost, in section 20-6-11, depth, 725 feet; Government well No. 2, in section 19-9-10, depth, 750 feet; Taber well, in section 32-9-16, depth, 670 feet; south of Retlaw, in section 28-11-17, depth, about 900 feet.

"All the waters are more or less saline in character. Those from the Beaver well, Government well No. 3, and the Foremost well fall into one group, possessing a saline content in the neighbourhood of 1,000 parts per million, the essential mineral constituent of which is sodium carbonate, amounting to approximately 860 p.p.m. or 60 grains per gallon. A small percentage of sodium sulphate is present in the water from the Beaver well; sodium chloride is present only in negligible amounts. Compounds of calcium and magnesium are practically absent.

"The water from Government well No. 2 is slightly more saline than the waters just discussed, the total saline content being 1,500 p.p.m., the sodium carbonate being somewhat higher and the sodium chloride distinctly higher though perhaps not excessive for a 'deep-seated' water.

"The water of the Taber well is more strongly saline than those discussed, with a total saline content of approximately 2,700 p.p.m. It has practically the same sodium carbonate content as the Government well No. 2 but contains much more sodium chloride.

"The water of the well 'south of Retlaw' is markedly the most saline of the series, with a saline content of approximately 6,000 p.p.m. In sodium carbonate, however, it is very similar to the waters of the three wells first considered, the additional salinity being due to a much larger sodium chloride content.

"The outstanding characteristics of these waters considered as a series are their practical freedom from calcium and magnesium compounds and their essential uniformity as regards sodium carbonate. It is the latter constituents which mark the element of danger in considering these supplies as water for irrigation purposes.

"Though in limited quantities and occasionally applied, the first three waters might be used for a time on soils with good drainage without marked injurious results, we are of the opinion that they are not safe or suitable waters for irrigation purposes."

Stock-watering Reserves.—During the year a somewhat special effort was made to complete the reinspection of these reserves and some pieces of land were found which are suitable for soldier settlement. The great bulk of these reserves do not constitute particularly good agricultural land and have been recommended for continuance as reserves, except in certain 'long grass' districts where there does not seem to be any necessity for these reserves.

One hundred and one reserves were inspected and reported on.

It is suggested that the time is not far distant when it will be possible to administer these stock-water reserves and sanctuaries, in such a manner as to make them serve the purpose for which they are actually intended. At the present time these sanctuaries are of very little use, because they are so heavily pastured all the year round that, if a year of drought does come, there will be no grass left on them.

There have been a number of complaints about these reserves, as handled at present, due to the fact that very often a lot of stock is driven by different owners on to a small reserve in a fenced district. The stock is given no further attention and wandering becomes a nuisance to the owners of the land near the reserve. In other cases the reserves are found completely fenced in and used exclusively by one individual who has usually let it be understood in the neighbourhood that he has a lease or some other right to the land.

The essential thing is to have all these reserves fenced and the grass all reserved from April 1 in every year until say the end of August when, unless a condition of drought is declared existent, the reserves could readily be leased for fall and winter pasture. These lands probably have a pastoral value at the present time sufficiently high to produce enough revenue to pay for all the fencing and provide for administration on sound business lines.

South Saskatchewan Diversion Project.—This project was first conceived by Mr. J. S. Dennis, when chief inspector of surveys for the Department of the Interior, who mentions it in his reports on irrigation for the years 1894, 1895, and 1896. Nothing was done, however, at that time and the project did not receive any further attention until 1911, when in that and the two following years extensive surveys and general studies were made by the Irrigation Branch of the Department of the Interior. The 1912-13 report of the Water Power Branch of the department contains a special report on this project by Mr. H. E. M. Kensit, C.E.

More recently the city of Moosejaw has again been considering this source of supply and in May, 1919, it is understood that a special report dealing with Moosejaw only was prepared and submitted to the city officials by Mr. George D. Mackie, City Engineer Commissioner.

The Government of the province of Saskatchewan has shown a great deal of interest in this project ever since the spring of 1911 when a report was submitted to them by Mr. T. Aird Murray, then consulting engineer to the Bureau of Health. It is understood that the Provincial Government has in succeeding years collected a great deal of useful information concerning this project.

During the summer and autumn of 1919 popular attention was again brought back to a realization of the fact that the South Saskatchewan river is the only sufficient available source of supply for the Regina-Moosejaw district, and the project is now being considered afresh by the Provincial Government. An Act was passed at the last session of the Saskatchewan Legislature providing for the appointment of a commission whose duty it will be to inquire fully into this matter and report to the Government. Mr. A. J. McPherson has been appointed chairman of this the Saskatchewan Water Supply Commission.

Sevenpersons Drainage Basin Investigation.—Shortly before the convention of the Western Canada Irrigation Association in Medicine Hat, August 4 to 6, 1919, the Board of Trade of that city took up the matter of the possibility of irrigating the lands in their immediate vicinity, and the department was asked to investigate the various sources of water supply available. On August 12, 1919, instructions were received to procure the necessary assistance to investigate the "feasibility of irrigating lands from water stored in Sevenpersons Creek drainage basin and to examine generally into the feasibility of irrigating other lands in the Medicine Hat district from any other source of supply."

Being late in the season, it was found difficult to obtain, on short notice, an engineer qualified to do the necessary field-work. After some delay from this cause, the field-work was finally begun by Mr. C. M. Moore on September 17, 1919.

It was suggested by interested parties that the proposed Lethbridge Southeast Project might be extended to cover some of this land. It is evident, however, that this could not be considered, because there is known to be more land which can be irrigated

within the boundaries of this project as proposed, than for which there is available water. Moreover, the carrying of this water of the Waterton, Belly, St. Mary and Milk rivers, such a long distance past these lands, with the attendant waste from seepage and evaporation, would be neither economical nor justifiable.

Another suggestion was pumping from the South Saskatchewan river. It was found that in order to cover any considerable body of land, the water would have to be lifted about two hundred feet. To pump water to this height for the purpose of raising such crops as can be grown in this district is not economically practicable at this time. There are known to be, however, a few small tracts lying along the river in this vicinity at a much less height above the stream and for this reason the matter of pumping was given careful consideration.

The fact that it is possible to obtain in this district a good supply of natural gas for power purposes at a capital cost of $2,000 per well makes it practicable to lift water to greater heights than would otherwise be possible. The cost of pumping plants for lifts of fifty to one hundred feet varies in this district from $97 to $145 per acre. While this is not a particularly attractive proposition for the farmer of small means, it is possible if the scheme can be financed, to profitably irrigate by this means small tracts lying at a height not in excess of one hundred feet above the stream.

It must be remembered, however, that in order to do this a large proportion of the land must be in high-priced crops, such as garden truck, corn, potatoes, field peas, etc., otherwise the returns will not be sufficient to pay interest on the investment. Starting with raw land, it takes two or three years to produce these crops and to establish the proper rotation. During this time the expenses will probably exceed the returns from the land by a considerable amount. After the third or fourth year, however, the scheme should be on a paying basis. Owing to the difficulty of getting the extra help necessary to raise this class of crops, it is recommended that these tracts should not exceed one hundred acres.

The only practical sources of supply for any large area of land in this vicinity are the streams Sevenpersons creek, Ross creek, and Bullshead creek. As the larger part of the water in these streams runs off during the months of March and April, it is evident that any scheme proposing to take water from them must depend almost entirely upon catching this water in reservoirs and holding it over for irrigating during May, June, and July.

When these investigations were commenced a reservoir had already been located on Ross creek by Mr. Cavan and others who are interested in irrigating from this source. They have since included this in an irrigation project covering about 4,000 acres, the surveys for which have been made by them. The available capacity of this reservoir which is located on the main stream just west of Pashley, is reported by them to be about 12,000 acre-feet. A canal has been located from this reservoir commanding land along the south side of Ross creek and adjoining the city of Medicine Hat on the west side of Bullshead creek. An irrigation district comprising this land is in process of formation and is to be known as the Medicine Hat Eastern Irrigation District. These parties have kept in close touch with this office and have at our suggestion incorporated many changes in their scheme in order to use all the water available in the most economical manner.

On Sevenpersons creek four reservoir sites on the main stream were surveyed, but only two of them were finally selected. The combined capacity of these is 26,145 acre-feet. In addition, two smaller sites were located separate from the main stream, which bring the total available storage on this stream up to about 27,660 acre-feet.

It is proposed to take the water out of the creek a short distance above the town of Seven Persons. Ditches have been located covering the land on each side of the creek between this point and Medicine Hat. It is evident, however, that, owing to the very limited water supply, only a small part of this land can be actually irrigated, probably not in excess of 5,300 acres. Under these conditions the available storage

would be developed to the extent of only 14,200 acre-feet. An irrigation district is being formed covering this area, to be known as the Medicine Hat Southern Irrigation District.

A study of the proposed water supply of the projects above mentioned shows that they probably could not receive the legal duty of water of one and one-half acre-feet of water every year. For this reason no recommendation has been made in regard to either scheme pending further investigation and study.

These investigations were commenced so late in the season that it was impossible to complete the field-work this year. Arrangements have been made to finish this work early next season.

Cypress Hills District, North—This district was covered as a combined irrigation and hydrometric district by Mr. M. H. French, who took the field on March 10, and completed his field-work on November 30. The season's work comprised two hundred and fifteen actual working days. One hundred and three irrigation inspections and seven surveys were made. Three hundred and twenty-two stream gaugings were made and four new gauging stations were established. The number of miles travelled by train was 2,506, by motor-car 6,997, and by other means 929. These figures include the work done on the special measurement of early spring run-off. The statements in the following paragraphs covering the Cypress Hills district in general have been extracted from a very interesting report submitted by Mr. French:—

"Irrigation in the Cypress Hills probably dates from the year 1889, when Daniel Braniff commenced to irrigate from Bear creek a two hundred-acre tract of land three miles south of the present site of the town of Piapot, Sask. The works were crude but served their purpose until replaced by those of a more permanent nature. From the outset, considerable success attended Mr. Braniff's experiments in growing native and cultivated grasses.

"During 1889-1900, the country was still an open range. Here and there in the shelter of the valleys could be found the low log buildings and corrals of the early settlers, but the prairie was still untouched by the hand of man. Grass was long and plentiful and the winter ranges excellent, hence, little attention was given to providing large quantities of hay for winter feeding, or engaging in the arduous pursuits of agriculture. Practically all work was done in the saddle.

"In 1900 the invasion of the farmers commenced—from the east and from the south. The earlier settlers awoke to the fact that their ranges would soon disappear, and that ere long some provision would have to be made for permanent hay meadows and pastures. They availed themselves of the privileges of the Irrigation Act and filed upon nearly all the valley lands in the district, which would lend themselves easily to irrigation. Structures were built, ditches were excavated, and the water was turned upon the land to spread at will, or to be guided by ditches and dikes. Only a small area of land was properly prepared, according to good irrigation practice. The construction work generally ceased with the completion of the main diversion works and ditches necessary for the obtaining of patent to the land.

"From the year 1914, when most of the construction work on the schemes was completed, very little further development took place. Considerable effort had been expended in the construction of the main works, but now only the most necessary labour was performed. This cessation may be attributed to a variety of causes, chiefly a period of uncertainty and suspense during the Great War and the scarcity and high price of labour. The enormous yields of 1915-16 under dry farming conditions assisted materially to discount the value of irrigation. But probably the greatest hindrance to further development of the schemes is the large area of the lands deeded to individuals. If a three hundred and twenty-acre tract of irrigated land constitutes a good-sized farm for one man of ordinary means to work successfully, it is detrimental to the fullest development of any district for individuals to acquire title to larger tracts. It is impossible for a person who has expended all his capital, or at

least all his surplus capital, in the construction of the main works, to develop very rapidly the distribution system and properly prepare the land. This results in many tracts of excellent land lying idle for years or else producing low yields, because of an inefficient system of irrigation. There is no doubt but that development would be more rapid, henceforth, if no more than three hundred and twenty acres of irrigable land were controlled by any one person.

"In this period there has been considerable deterioration of the works upon practically all schemes. In not a few instances the main diversion works have been totally destroyed. Many structures are of wood, crudely designed, and have been in use several years. Also, a large number of ditches have never been cleaned out since constructed and are now badly choked with weeds and débris. Thus much work is required to put nearly every scheme in the same state of repair that existed before the war.

"In 1919, however, as a result of three consecutive dry years, the business men and the irrigators of the district began again to take an active interest in irrigation. Feed was scarce, the pastures were eaten off, and there was no possible way to carry a large number of stock through the winter. Many people had already received governmental assistance, and besides, were heavily in debt to merchants, and to implement men for farm supplies. The business men were staggering under a load of credit granted to the farmers. With no feed on hand, and the probability of a hard winter ahead, the situation looked indeed critical. However, if the material assets of the people were low, their stock of perseverance and optimism was not exhausted.

"Irrigation was looked upon by many as a means of providing the necessary feed to save and revive a rapidly perishing stock industry. Hence, everybody became enthusiastic about the need for reservoirs to conserve the flood waters now going to waste. This was especially noticeable among the people resident in the Battle Creek valley and among the enterprising business men of Medicine Hat.

"Irrigation development is more marked in the Battle Creek valley than in any other part of the district. This is no doubt due to the comparatively inexpensive diversion works required, the large area of irrigable land available, and the excellent water supply. The greater portion of the irrigable land along the creek is now under irrigation to the extent that the present works will permit of a delivery of water to each quarter-section. To spread the water over the land requires, on most schemes, considerable further expenditure in the construction of field laterals, dikes, etc., and also in the proper preparation of the land. The main works are, through lack of proper maintenance, falling into a state of disrepair and their usefulness is thereby greatly diminished. Generally speaking, the schemes are rather large for the irrigators to fully develop in the immediate future.

"The irrigators and farmers in the Consul and Vidora districts became quite enthusiastic regarding the necessity for irrigation. Especially, they considered the construction of the Cypress Lake reservoir urgent; also that of a large scheme to serve much land near Vidora. Representatives from the above towns attended the irrigation convention at Medicine Hat in August and submitted petitions for the immediate commencement of this work. As an outcome, a preliminary reconnaissance was made of all irrigable land in the valley. This was for the purpose of obtaining information to use in the planning of future surveys, and also to form the basis for preliminary studies relating to the diversion of the water of the reservoir between the valleys affected.

"The Cypress Lake reservoir will be of inestimable value in contributing materially to the fuller agricultural development of the Battle Creek valley. It will not only increase the value of the present licensed schemes, but will also permit of the irrigation of a considerable area near the towns of Consul and Vidora, which is now being dry farmed. The value of this irrigation to the adjacent dry land is also considerable.

"The construction of the Cypress Lake reservoir and its main distribution systems will afford an interesting study in irrigation economics and design, in order that the limited water supply may be allotted to each farm unit of irrigable land in such quantities as to give the greatest monetary returns per acre-foot of water. The system should be somewhat elastic, so that every acre would be guaranteed a minimum quantity when the supply is limited, and a maximum quantity when the supply is plentiful. Because the fluctuation of the supply is greater than the quantities to be applied to the land, it will no doubt be economical to carry over the peak of the maximum year's run-off to supply the deficiency in extremely dry years. But generally speaking, the run-off each year should be used the same year. The principle to be followed in any study should be to provide as many farmers as possible with at least a small area of irrigated land upon which to grow the roughage required for the keeping of the necessary farm animals, such as dairy cattle, horses and hogs.

"Irrigation in the Frenchman valley cannot be so favourably mentioned as that of the Battle Creek valley. The quality of much of the soil between Cypress lake and the mouth of Fairwell creek is poor because of the high alkaline content. From the latter point to the station at Knollys there is no land which can be irrigated by a gravity system. Below Knollys and in the vicinity of East End there is considerable irrigable land, but the cost of diversion works is so great that it is expensive to put it under irrigation, unless under one main system. The Morrison and Strong schemes, which diverted water from the Frenchman river near East End, have ceased to exist as gravity schemes. They have been out of operation over two years since the destruction of their dams by floods. A small part of the Strong flat is to be irrigated from Gallienne coulee by a gravity system, and two small tracts on the Morrison flat were successfully irrigated last season by pumping plants. It is probable that no further permanent irrigation development will take place in that part of the valley until the formation of an irrigation district, and the creation of one large scheme to serve all the land. This would insure a productive and prosperous valley. The owners of the lands are favourably disposed towards the creation of such a district, and, no doubt, in the near future, will decide to organize.

"This district would be materially benefited by the construction of the Cypress Lake reservoir. Under the present conditions of stream flow there is ample water for that land until June, after which the supply would need to be augmented from Cypress lake.

"The development of the Maple Creek valley consists of a few small schemes in the foot-hills, south of the Canadian Pacific railway, and of several larger schemes along the lower part of the valley, north of the track. Hay constitutes the main crop and is irrigated chiefly during high and flood stages. The works are inexpensive, and the free-flooding system is practised. Most of the works are old and badly decayed and the ditches partly choked with grass and débris. The schemes are rather large for one man to thoroughly develop. Many of the owners are also interested in other lines of business and therefore do not give the irrigation of the land sufficient attention.

"The Maple Creek valley is well supplied with a number of small reservoir sites which would materially benefit the lands below. They have already been surveyed, except Sixteen Mile lake, which is located sixteen miles north of Maple Creek. This lake, as mentioned in a report on file, will impound considerable water at an extremely low cost, would check the overflow of Maple creek near the Tenaille dam and would prevent any further damage to the Provincial Government bridge across Bitter lake, north of Forres. This matter should be thoroughly investigated early next season. A reconnaissance of all irrigable lands in the valley also requires attention at an early date.

"The valley of Mackay creek is only partially developed. Most of the schemes lie north of the Canadian Pacific railway, in the vicinity of Many Island lake. The works consist largely of inexpensive diversion dams, which permit the water to be turned out upon the flat on either side of the creek and to spread at will. When water

is plentiful, considerable quantities of wild hay are cut; otherwise, most of the land is used for pasture. As in other valleys the owners have a diversity of interests and therefore do not have the same stimulus towards further development of the irrigation schemes as they would if their livelihood depended upon the success or failure of small fields of grain.

"Last year a preliminary survey was made of a feasible reservoir site south of the town of Walsh. This site is only of limited capacity and will impound, in average years, an amount which will probably not exceed one-third of the annual run-off. This water, however, will supply a midsummer irrigation of six inches to a few thousand acres of land. Owing to the small capacity of the reservoir it will be impractical to carry any water over until a following season. The losses from seepage and evaporation will be low, since the water will not be held in the reservoir longer than from March 15 until possibly July 15, a period of four months.

"In connection with reservoir construction in the Cypress hills, the question of the apportionment of the water among the irrigators is of vital importance. There is no doubt but that, if the cost of any reservoir is contributed by the irrigators on a pro-rata basis, according to the area of land served, the water should be divided on a somewhat similar basis, irrespective of stream priorities. This would not affect any irrigator's priority rights for water diverted directly from the creek and not impounded in a reservoir. The right of an irrigator to divert water from a stream is a vested right granted by the Crown; while the right of an irrigator to impounded water should be regulated by the rules of agreement among the irrigators interested in the reservoir.

" Along the sinuous course of the South Saskatchewan river, in the vicinity of Medicine Hat, lie numerous tracts of river-bottom land. These are suitable for irrigation and are only waiting the application of water to be quickened into wonderful productivity. With an apparently unlimited supply of natural gas only about 700 feet beneath the surface (and a limited supply at 300 feet in certain places), nature has provided an inexpensive source of power with which to operate the machinery to lift the water a distance of about 50 or 60 feet from the river to the land. The altitude of these lands is comparatively low, the climate mild, and the soil loamy and productive. Furthermore, these small tracts lie adjacent to large grazing leases, over which roam herds of stock, requiring an abundance of roughage for winter feeding. What an ideal combination nature has bestowed upon these river-bottom lands for men with a moderate amount of capital to develop into successful stock farms and beautiful rural homes!

" Natural gas provides a source of cheap light for the house and buildings, and of cheap power for the operation of all farm machinery, such as churns, washing machines, feed-grinders, fanning mills and separators. When the crops require water all that is required is the proper manipulation of a couple of levers when, as if by magic, the powerful engine causes a large stream of water to flow through the ditches and over the fields, making them appear like an oasis on a grass-withered prairie. Moreover, by a liberal application of water a grove of trees can be grown which will not only beautify the grounds but will also serve as a wind-break.

" One of the pioneers of this district in irrigating by pumping with natural gas as fuel is Mr. Chas. Lokier, who lives about forty miles north of Medicine Hat. He is gradually developing an irrigated farm that will be a credit to the community. Another man who has, during the past two years, put considerable serious thought and work into developing an irrigation scheme along the Saskatchewan river, is James Mitchell, of Medicine Hat. He is desirous of growing alfalfa for winter-feeding stock. Regarding the results which may be obtained from irrigating these river-bottom lands, one need only refer to the results being accomplished from a similar piece of land, owned and operated by the Canada Land and Irrigation Company, near Ronalane, Alberta."

Cypress Lake Reservoir.—The construction of this reservoir has for many years been looked upon as the logical means of controlling and conserving the flood run-off from the upper watersheds of Battle creek and the Frenchman river. The pressing need

for this reservoir can be readily seen when it is pointed out that, while to-day much good land below this reservoir lacks a supply of irrigation water, at the same time roughly seventy-five per cent of the total run-off of the two streams comes down in March and April and is practically all wasted.

The reservoir site was first surveyed in 1909, but this survey was not sufficiently complete. The reservoir site was completely surveyed in 1913 by Mr. N. M. Sutherland of the Irrigation Branch. It was found by this survey that the natural water surface elevation of the lake was 3,154 feet. With the water surface raised to 3,170 feet the capacity would be nearly 90,000 acre-feet, and with water surface raised to 3,176 the capacity would be nearly 127,000 acre-feet. At this time it was assumed that the reservoir should be built to the larger capacity to provide storage for all the flood flow that could be conserved and to provide the best supply possible for the estimated area of 24,000 acres in the Frenchman valley and 7,000 acres in Battle Creek valley.

This question was studied again in 1917 when the commissioner prepared a paper on reservoirs in the Cypress Hills district which was read before the convention of the Western Canada Irrigation Association at Maple Creek. At this time there were much better records available on which to base studies of water supply and demand. The conclusion arrived at was that a reservoir capacity of 90,000 acre-feet would be sufficient. This study was based on storing all the water available, absorption losses of three feet in the reservoir and a gross duty at the reservoir of 1.5 acre-feet. This study contemplated the use of the stored water on about 7,000 acres in Battle Creek valley and about 14,000 acres in the Frenchman valley.

At the present time there is considerable activity directed towards the construction of this reservoir by forming all the lands which would be benefited, into an irrigation district. Tentative studies recently made, confirm the conclusions arrived at in 1917 that a capacity of 90,000 acre-feet is sufficient. There are two particular points of difference, however, in the more recent contemplation of this development. One is the present strong desire to utilize a large portion of the stored water outside of the actual valley lands of Battle creek by carrying the water out onto the bench lands in the Vidora district. The other point is that, of the 14,000 acres to be irrigated in the Frenchman valley nearly 9,000 acres lie below the Fifty Mile reservoir (tp. 5, rge. 16, W. 3rd mer.). Previously it was proposed to store water in the Cypress reservoir for these lands below the Fifty Mile reservoir, while now it is contemplated to make the Fifty Mile reservoir take care of the lands below it. This relieves the draft on the Cypress reservoir to the extent of nearly 9,000 acres and leaves only about 5,000 acres in the Frenchman valley to be provided for by the Cypress reservoir.

Nothing concrete in the way of actual development has been done on this project up to date, largely because it was an undertaking of such magnitude as to require co-operative effort by all of the large number of persons who would be benefited, and also because no means were available for gaining the necessary co-operative effort. The passage of the Irrigation Districts Act in Saskatchewan has now provided the necessary machinery for co-operative action and in all probability the new Act will first be applied in forming an irrigation district which will be supplied by the water stored in this reservoir.

During the late autumn of 1919 Mr. M. H. French made a partial reconnaissance of the valleys of Battle creek and Frenchman river to gain further information concerning the area of land which was susceptible of irrigation from this reservoir. This reconnaissance developed the fact that outside of the valley lands there was a large area of desirable bench land which could be served lying to the east of Battle creek and in the vicinity of Consul, Vidora and Robsart (on the Canadian Pacific Railway Lethbridge-Weyburn branch south of Maple Creek). It is proposed to make instrumental surveys during 1920 to determine the area of irrigable land under this reservoir and to prepare a plan for the most beneficial development of an irrigation district.

The interested people in the area which may be benefited have, during the past winter, shown a good deal of interest and activity in this matter and appear anxious for some actual development at as early a date as possible. This point has been referred to in Mr. French's report which is quoted in part under the caption "Cypress Hills District, North." It is understood that some petitions for the erection of a district have already been circulated, but no definite information on this point has yet come to hand as this report is being written.

Cypress Hills District, South.—This district was covered by Mr. R. H. Goodchild, who returning from active overseas service on July 23, made a very late start on the work on August 2, and stopped the work on account of bad weather on November 9. The season's work comprised sixty-four actual working days. Seventy-two irrigation inspections and twenty-eight surveys were made. The number of miles travelled by train was 635 and by other means, mainly horse vehicle, 1,255. The conditions in this district were very difficult during the season. There was really more work to do in the short time available than could be handled by one inspector. Mr. Goodchild tried to cover all the territory by hurrying through his work, which created a very undesirable condition. Most of the work was given complete or partial attention during the season, but the work left over, added to the new applications which have been received, is going to make such a heavy list, that it is doubtful if all the work can be properly looked after during the coming season.

Macleod District—This district was covered as a combined irrigation and hydrometric district by Mr. A. W. P. Lowrie, who took the field on April 17, and completed his field-work on February 3, 1920. The season's work comprised two hundred and forty-seven actual working days. One hundred and one irrigation inspections and nine surveys were made. Four hundred and three stream gaugings were made. The number of miles travelled by train was 3,272, by motor-car, 9,146, and by other means, 386. The following interesting information has been taken from Mr. Lowrie's annual report.

"The Macleod district this year included the foot-hills country from Midnapore south to the headwaters of the Oldman river and extending from the British Columbia boundary to the AAldersyde branch of the Canadian Pacific railway. The foot-hills portion of the district is devoted largely to the raising of cattle and horses and there are several large ranches in the hills. Farther out on the prairie there are some splendid wheat districts. In the Pincher Creek and Cowley districts fall wheat is largely grown, but farther north spring wheat is seeded.

"The irrigation schemes in the district are all small and the sources of supply have hitherto been from spring creeks as it was usually found too expensive for individuals to attempt taking water from the rivers. The schemes, for the most part, lie in the hills and were constructed for the irrigation of forage crops.

"In a great many cases, owing to the shortage of labour during the war, and the fact that a good many of the owners were on active service, the works have been allowed to fall into disrepair. In other cases, owing to a series of unusually dry years, the water supply had failed, so that there was not enough water to be of any practical value. In two or three cases, however, efforts have been made to have the schemes in shape and they have been used successfully during 1919. A great number of new applications for irrigation rights in the district have been made during the latter part of the season. On account of the early setting in of winter these could not all be inspected this season. A number of these applications are for rights to pump from the rivers. The present high prices for feed of any kind have made it possible to irrigate at a much greater expense than formerly and this accounts for the interest taken in pumping projects.

"The season of 1919 was unusually dry. There was practically no snowfalls during the winter of 1918-19 and the rainfall was away below normal during the summer. Rain started in August, however, and during the latter part of the year a good deal

of moisture fell before the ground froze and there should be a fair reserve supply for the spring crops of 1920. The freeze-up started about the 23rd of October, at least a month earlier than usual. The cold weather started with very heavy snowstorms and there was hardly any good weather from that time until the middle of December. The winter was consistently cold throughout and much of the pasture land was still covered with snow in the second week of April, 1920.

"The foot-hills country was generally considered to have a sufficient rainfall to grow a crop even during seasons considered dry farther out on the prairie; but during 1918 the rainfall was very light and during the winter of 1918-19, as mentioned above, there was practically no snowfall. Consequently there was no reserve of moisture in the ground in the spring of 1919, and even the grass did not grow. With a crop failure in 1918 and a partial one in 1917, the farmers and ranchers started the spring with practically no reserve of feed and the grass was grazed to the roots during the summer of 1919.

"The early winter caught all the ranchers unprepared and consequently the stock suffered greatly. Feed had to be shipped in and this was so slow in coming and proved so expensive that many considered it better to sell their stock, while others shipped their cattle north to feed. The lighter grades of horses were not considered of enough value and were left to rustle for themselves; the loss has been heavy amongst these. North of Claresholm the August rains mentioned above rather saved the situation, as heavy crops of green feed were raised after the rains fell. But from Claresholm south these rains did not occur and throughout the Cowley and Pincher Creek districts the sacrifice of stock has been large. It is stated that some 30,000 head were shipped out of this district."

Special Inspections—Domestic, Municipal, Irrigation and Industrial—This work was carried on under the immediate supervision of the acting office engineer, Mr. E. L. Miles, until the middle of August when Mr. P. J. Jennings returned from active service Overseas and resumed his position as office engineer. The office engineer supervises the work of all inspecting engineers and particularly that of the two special inspectors. In addition to this he checks all plans received from the inspecting engineers and generally looks after all routine matters in connection with surveys and plans other than those relating to the large survey parties.

The total number of inspections made in Saskatchewan by Mr. W. B. Hutcheson was seventy, including thirteen surveys of all descriptions involving 9,307 miles of travel by train, and 2,346 miles by motor-car or other means. The total number of inspections made in Alberta by Mr. C. Chambers was forty-eight, including eleven surveys involving 4,352 miles of travel by train, and 1,451 miles by motor-car or other means.

It may be of interest to note the movement which has taken place during the past year in connection with the extraction of mineral salts and mineral "oil" from certain of the lakes in Saskatchewan.

In one instance a live industry is being developed by a one man plant, the works being crude but effective. The salts and "oils" appear to find a ready sale for medicinal purposes. In this case the waters contain 68 per cent of sodium chloride, 15 per cent magnesium sulphate, 5 per cent potassium sulphate, 5·1 per cent calcium sulphate and a small percentage of magnesium bicarbonate and sodium sulphate.

In another lake near Fusilier, Sask., a solid bed of sodium sulphate some eleven feet thick is about to be developed, the chemical analysis of which shows over 99 per cent pure Glauber salts and the balance potash, magnesium and organic matter. This natural resource which has been lying undeveloped is worth $28 per ton on the eastern markets for use in the pulp industry, and as 300 pounds of salt cake are used per ton of pulp, some idea of the demand will be obtained.

A further interesting application is under investigation in connection with the extraction of common salt from a number of brine springs in the bed of a lake near Senlac, Sask. In this case the tests reported show a heavy percentage of pure sodium

chloride and experiments with evaporating the water by a simple natural process have given highly satisfactory results. As common salt is worth $35 per ton and table salt $85 per ton, wholesale, in Saskatchewan to-day, it should be possible and profitable to develop these springs. The supply for the prairie provinces is at present imported from Utah, U.S.A., or from Windsor, Ont.

It is probable that the cycle of dry years recently experienced has exposed these salt deposits and brought them to the public notice. A cycle of wet years will undoubtedly fill up many of those lake beds again and in this event the salt solution will become much diluted, requiring a more expensive dehydration treatment or the removal of the surface water by means of drainage.

MUNICIPAL WATER CONSUMPTION DATA

The collection and compilation of municipal water consumption data were inaugurated towards the end of the year 1914, and in the year 1915 we received information complete for the year from fifteen cities and towns in Alberta and Saskatchewan. In the following year we received records for the whole year from the same cities and towns. During the year 1916 an endeavour was made to obtain these data from a greater number of places, with the result that for the year 1917 we received complete records from twenty-one cities and towns in Alberta and Saskatchewan. During 1919 records were received from eighteen cities and towns. These records have been compiled in a manner similar to former years and are submitted hereunder:—

Cities and Towns in the Province of Alberta.—Daily Record of Water Consumption in Imperial Gallons for the Year 1919.

1919. — Month.	Edmonton.						Lethbridge.					
	Population 60,000.						Population 14,000.					
	Daily Average for the Month.	Per Head for domestic purposes	Per Head for industrial purposes	Per Head for other purposes	Per Head for all purposes	Unaccounted for.	Daily Average for the Month.	Per Head for domestic purposes	Per Head for industrial purposes	Per Head for other purposes	Per Head for all purposes	Unaccounted for.
January	5,107,225	53·9	23·9	7·3	85·1	....	1,250,677	64·9	24·4	....	89·3	....
February	5,332,928	57·4	23·7	7·7	88·8	....	1,278,464	65·7	25·6	....	91·3	....
March	5,503,232	57·4	25·5	8·7	91·7	....	1,309,129	65·7	27·7	....	93·4	....
April	5,406,866	56·9	25·2	7·9	90·1	....	1,384,000	70·5	28·3	....	98·8	....
May	5,319,300	55·7	24·6	8·4	88·7	....	1,522,322	79·9	28·3	0·35	108·7	....
June	5,283,000	56·8	24·2	7·1	88·0	....	1,815,533	96·7	27·8	5·06	129·6	....
July	5,510,000	56·2	24·7	10·7	91·8	....	2,009,161	111·3	25·4	6·8	143·5	....
August	5,383,677	56·5	24·2	9·5	89·7	....	1,728,060	78·8	25·5	8·1	112·3	....
September	5,340,266	56·2	24·1	8·6	89·0	....	1,484,566	71·7	27·8	6·5	106·1	....
October	5,399,226	56·2	24·2	9·6	89·9	....	1,470,967	77·5	25·2	....	102·7	....
November	6,145,700	58·6	25·3	11·9	102·4	....	1,447,333	77·8	25·5	....	103·3	....
December	6,264,355	59·4	25·7	19·3	104·4	....	1,520,806	77·7	30·9	....	108·6	....
Av. for yr.	5,499,648	56·7	24·6	9·7	91·7	....	1,520,918	78·1	26·9	....	107·3	....

1919. — Month.	Medicine Hat.						Redcliff.					
	Population 11,000.						Population 2,200.					
	Daily Average for the Month.	Per Head for domestic purposes	Per Head for industrial purposes	Per Head for other purposes	Per Head for all purposes	Unaccounted for.	Daily Average for the Month.	Per Head for domestic purposes	Per Head for industrial purposes	Per Head for other purposes	Per Head for all purposes	Unaccounted for.
January	2,305,806	....	....	....	209·6	....	141,226	55·8	8·4	....	64·2	....
February	2,225,714	....	....	....	202·3	....	131,411	50·3	9·4	....	59·7	....
March	2,322,258	....	....	....	211·1	....	218,669	94·3	5·1	....	99·4	....
April	2,252,666	....	....	....	204·7	....	181,133	68·6	13·7	....	82·3	....
May	2,753,226	....	....	....	250·3	....	209,887	82·7	12·6	....	95·4	....
June	3,404,333	....	....	....	309·1	....	203,683	80·6	11·8	....	92·5	....
July	3,666,129	....	....	....	333·2	....	243,952	92·1	18·8	....	110·9	....
August	2,990,000	....	....	....	271·8	....	230,468	87·5	17·2	....	104·7	....
September	2,481,000	....	....	....	255·5	....	233,576	89·7	16·4	....	106·1	....
October	2,076,666	....	....	....	182·7	....	223,726	83·2	18·5	....	101·7	....
November	2,127,666	....	....	....	193·4	....	209,183	77·2	17·9	....	95·1	....
December	2,174,193	....	....	....	197·6	....	223,900	87·0	14·8	....	101·8	....
Av. for yr.	2,565,055	....	....	....	234·3	....	204,234	79·1	13·7	....	92·8	....

Cities and Towns in the Province of Alberta.—Daily Record of Water Consumption in Imperial Gallons for the Year 1919

1919. — Month.	Stettler. Population 1,400.						Claresholm. Population 1,100.					
	Daily Average for the Month.	Per Head for domestic purposes	Per Head for industrial purposes	Per Head for other purposes	Per Head for all purposes	Unaccounted for.	Daily Average for the Month.	Per Head for domestic purposes	Per Head for industrial purposes	Per Head for other purposes	Per Head for all purposes	Unaccounted for.
January.....	11,586	4·5	3·8	....	8·2	....	64,500	55·4	2·8	0·4	58·7	....
February...	12,142	5·6	3·0	....	8·6	....	73,928	50·7	16·6	....	67·2	....
March......	19,193	13·1	0·6	....	13·7	....	51,294	40·5	6·1	....	46·6	....
April.......	11,731	4·7	3·6	....	8·3	....	15,229	8·9	2·0	....	11·0	....
May........	13,449	6·4	3·2	....	9·6	....			No supply.			
June........	16,879	....	....	....	12·0	....	70,488	....	....	....	64·0	....
July........	15,415	....	....	....	10·7	....	94,193	....	....	....	85·6	....
August......	15,157	....	....	....	10·5	....	81,035	....	....	....	73·7	....
September..	20,159	....	....	....	14·3	....	....	....	....	....	....	....
October.....	14,573	....	....	....	10·4	....	....	....	....	....	....	....
November..	13,070	....	....	....	9·3	....	....	....	....	....	....	....
December..	13,599	6·0	3·7	....	9·7	....	....	....	....	....	....	....
Av. for yr..	14,744	....	....	....	10·4	....	64,381	....	....	....	....	....

1919. — Month.	Bassano. Population 800.						Athabaska. Population 500.					
	Daily Average for the Month.	Per Head for domestic purposes	Per Head for industrial purposes	Per Head for other purposes	Per Head for all purposes	Unaccounted for.	Daily Average for the Month.	Per Head for domestic purposes	Per Head for industrial purposes	Per Head for other purposes	Per Head for all purposes	Unaccounted for.
January.....	131,450	39·3	125·0	....	164·3	....	12,097	24·2	....	....	24·2	....
February...	136,000	45·0	125·0	....	170·0	....	16,071	32·1	....	....	32·1	....
March.....	129,032	....	....	....	161·3	....	13,065	26·1	....	....	26·1	....
April......	131,333	....	....	....	164·1	....	21,875	43·7	....	....	43·7	....
May........	161,452	....	....	....	209·7	....	12,000	23·2	....	....	23·2	....
June.......	168,500	....	....	....	210·6	....	12,000	24·0	....	....	24·0	....
July........	175,484	....	....	....	219·3	....	4,295	8·6	....	....	8·6	....
August......	185,645	....	....	....	232·5	....	3,508	7·0	....	....	7·0	....
September..	162,500	....	....	....	203·1	....	14,400	28·8	....	....	28·8	....
October.....	166,451	....	....	....	208·1	....	15,605	31·2	....	....	31·2	....
November..	160,166	....	....	....	200·2	....	13,709	28·3	....	....	28·3	....
December.	154,000	....	....	....	192·9	....	18,024	36·5	....	....	36·5	....
Av. for yr..	155,168	....	....	....	194·7	....	13,054	26·1	....	....	26·1	....

1919. — Month.	Carmangay. Population 332.					
	Daily Average for the Month.	Per Head for domestic purposes.	Per Head for industrial purposes.	Per Head for other purposes.	Per Head for all purposes.	Unaccounted for.
January..............................	10,831	32·8	....	....	32·8	....
February............................	11,143	32·5	....	1·3	33·8	....
March................................	10,064	30·5	....	....	30·5	....
April..................................	11,500	33·9	....	....	33·9	....
May....................................	11,613	31·6	....	3·6	35·2	....
June...................................	12,000	36·3	....	....	36·3	....
July....................................	12,000	36·1	....	....	36·1	....
August................................	12,000	36·1	....	....	36·1	....
September..........................	8,800	26·6	....	....	26·6	....
October..............................	10,451	31·6	....	....	31·6	....
November...........................	11,600	29·1	....	6·1	35·2	....
December............................	12,000	32·7	....	3·5	36·2	....
Average for the year..................	11,167	32·5	....	1·2	33·7	....

Cities and Towns in the Province of Saskatchewan.—Daily Record of Water Consumption in Imperial Gallons for the Year 1919

1919. — Month.	Regina. Population 40,000.						Saskatoon. Population 28,000.					
	Daily Average for the Month.	Per Head for domestic purposes	Per Head for industrial purposes	Per Head for other purposes	Per Head for all purposes	Unaccounted for.	Daily Average for the Month.	Per Head for domestic purposes	Per Head for industrial purposes	Per Head for other purposes	Per Head for all purposes	Unaccounted for.
January	1,981,098	40·1	8·4	....	49·5	....	1,458,096	25·5	15·2	0·2	53·5	12·5
February	1,981,098	41·3	9·0	0·02	50·4	....	1,500,107	25·5	15·2	0·2	53·5	12·5
March	2,015,245	40·0	9·5	....	49·5	....	1,536,774	25·5	15·2	0·2	53·5	12·5
April	1,967,071	40·0	6·8	0·22	47·0	....	1,673,000	28·1	15·4	3·9	67·5	20·1
May	1,889,096	39·8	8·1	0·12	48·0	....	1,878,030	28·1	15·4	3·9	67·5	20·1
June	2,216,549	48·0	7·3	0·11	55·4	....	2,238,346	28·1	15·4	3·9	67·5	20·1
July	2,030,514	41·8	8·8	0·13	50·7	....	2,153,548	30·7	15·3	2·6	70·8	22·1
August	1,988,564	41·6	8·0	0·09	49·6	....	1,939,161	30·7	15·3	2·6	70·8	22·1
September	2,021,262	43·1	7·3	0·02	50·5	....	1,850,200	30·7	15·3	2·6	70·8	22·1
October	2,206,938	45·3	9·8	0·07	55·1	....	1,837,774	28·0	19·2	0·71	64·8	16·1
November	2,103,110	43·7	8·8	....	52·6	....	1,761,366	28·0	19·2	0·71	64·8	16·8
December	2,226,758	47·9	7·8	....	55·7	....	1,841,290	28·0	19·2	0·71	64·8	16·8
Av. for yr.	2,052,275	42·8	8·3	....	51·2	....	1,805,641	28·0	16·3	1·9	64·1	17·9

1919. — Month.	Moosejaw. Population 21,000.						North Battleford. Population 4,000.					
	Daily Average for the Month.	Per Head for domestic purposes	Per Head for industrial purposes	Per Head for other purposes	Per Head for all purposes	Unaccounted for.	Daily Average for the Month.	Per Head for domestic purposes	Per Head for industrial purposes	Per Head for other purposes	Per Head for all purposes	Unaccounted for.
January	849,000	27·1	13·3	....	40·4	....	113,790	8·7	1·5	3·4	28·4	14·8
February	726,000	23·4	11·2	....	34·6	....	130,000	11·6	1·3	4·0	32·3	15·4
March	644,000	20·5	10·2	....	30·7	....	76,300	8·6	0·3	2·9	19·1	7·3
April	819,000	27·4	11·5	....	39·0	....	137,487	12·7	1·0	3·5	34·3	17·1
May	905,000	31·2	11·9	....	43·1	....	137,100	12·1	0·2	8·0	29·0	8·7
June	1,018,000	34·7	13·7	....	48·4	....	125,946	12·9	1·4	4·4	26·6	7·9
July	1,028,000	22·4	26·5	....	48·9	....	124,820	13·6	3·9	5·4	26·5	3·6
August	1,010,000	33·3	14·7	....	48·0	....	107,745	11·4	2·5	3·8	22·8	5·1
September	717,000	18·1	16·0	....	34·1	....	131,910	11·3	1·6	3·7	28·0	11·4
October	769,000	20·1	16·4	....	36·5	....	140,013	9·9	2·5	3·6	29·6	13·6
November	830,000	20·8	18·7	....	39·5	....	137,730	14·4	2·5	2·6	34·2	14·7
December	766,000	18·6	17·8	....	36·4	....	184,000	11·2	1·1	6·8	46·0	26·8
Av. for yr.	840,083	24·8	15·1	....	39·9	....	128,903	11·5	1·6	4·4	29·7	12·2

1919. — Month.	Weyburn. Population 4,000.						Estevan. Population 3,000.					
	Daily Average for the Month.	Per Head for domestic purposes	Per Head for industrial purposes	Per Head for other purposes	Per Head for all purposes	Unaccounted for.	Daily Average for the Month.	Per Head for domestic purposes	Per Head for industrial purposes	Per Head for other purposes	Per Head for all purposes	Unaccounted for.
January	84,868	21·8	....	....	21·8	....	31,190	7·7	2·7	....	10·4	....
February	90,246	22·6	....	....	22·6	....	32,750	7·9	2·9	....	10·9	....
March	98,037	23·7	....	....	23·7	....	31,190	7·7	2·7	....	10·4	....
April	99,812	24·9	....	....	24·9	....	31,933	7·7	2·7	....	10·6	....
May	94,826	23·7	....	....	23·7	....	42,903	11·6	2·8	....	14·3	....
June	108,870	27·2	....	....	27·2	....	58,666	12·8	6·7	....	19·5	....
July	108,121	27·0	....	....	27·0	....	44,193	11·5	3·2	....	14·7	....
August	108,525	27·1	....	....	27·1	....	44,413	10·6	3·2	....	13·8	....
September	97,895	24·4	....	....	24·4	....	37,566	9·1	3·3	....	12·5	....
October	94,325	23·6	....	....	23·6	....	33,806	9·5	1·7	....	11·1	....
November	116,709	29·2	....	....	29·2	....	33,266	9·3	1·7	....	11·1	....
December	120,625	30·8	....	....	30·8	....	32,258	9·0	1·7	....	10·7	....
Av. for yr.	101,905	25·5	....	....	25·5	....	37,844	9·6	2·9	....	12·5	....

Cities and Towns in the Province of Saskatchewan—Daily Record of Water Consumption in Imperial Gallons for the Year 1919.—Concluded.

1919. — Month.	Kamsack.						Battleford.					
	Population 1,600.						Population 1,500.					
	Daily Average for the Month.	Per Head for domestic purposes	Per Head for industrial purposes	Per Head for other purposes	Per Head for all purposes	Unaccounted for.	Daily Average for the Month.	Per Head for domestic purposes	Per Head for industrial purposes	Per Head for other purposes	Per Head for all purposes	Unaccounted for.
January	222,935	27·8	111·5	0·04	139·3	....	12,666	7·3	....	....	7·3	....
February	225,321	43·6	97·1	0·06	140·8	....	11,936	10·0	....	....	10·0	....
March	224,968	48·8	91·7	0·05	140·6	....	15,000	7·9	....	....	7·9	....
April	203,700	38·7	86·5	2·10	127·3	....	10,968	8·4	....	....	8·4	....
May	202,226	42·6	78·2	5·50	126·4	....	15,871	10·6	....	....	10·6	....
June	143,400	26·8	57·5	5·20	89·6	....	20,866	13·9	....	....	13·9	....
July	....	....	....	....	....	....	39,354	26·2	....	....	26·2	....
August	....	....	....	....	....	....	30,968	20·6	....	....	20·6	....
September	....	....	....	....	....	....	32,000	21·3	....	....	21·3	....
October	....	....	....	....	....	....	32,909	21·9	....	....	21·9	....
November	....	....	....	....	....	....	28,666	19·1	....	....	19·1	....
December	....	....	....	....	....	....	29,679	19·8	....	....	19·8	....
Av. for yr	....	....	....	....	....	....	23,407	14·8	....	....	14·8	....

1919. — Month.	Kindersley.					
	Population 1,000.					
	Daily Average for the Month.	Per Head for domestic purposes.	Per Head for industrial purposes.	Per Head for other purposes.	Per Head for all purposes.	Unaccounted for.
January	8,532	8·5	....	....	8·5	....
February	5,928	5·9	....	....	5·9	....
March	6,774	6·7	....	....	6·7	....
April	9,068	9·0	....	....	9·0	....
May	7,694	7·7	....	....	7·7	....
June	8,748	8·7	....	....	8·7	....
July	8,869	8·8	....	....	8·8	....
August	8,860	8·8	....	....	8·8	....
September	7,066	7·0	....	....	7·0	....
October	8,323	8·3	....	....	8·3	....
November	5,463	5·4	....	....	5·4	....
December	8,645	8·6	....	....	8·6	....
Average for the year	7,827	7·8	....	....	7·8	....

Record of Average Daily Water Consumption in Imperial Gallons for Years 1915-16-17-18-19.

ALBERTA.

Year.	Per Head Domestic.	Per Head Industrial.	Per Head Other Purposes.	Per Head All Purposes.	Unaccounted for.	Per Head Domestic.	Per Head Industrial.	Per Head Other Purposes.	Per Head All Purposes.	Unaccounted for.	Per Head Domestic.	Per Head Industrial.	Per Head Other Purposes.	Per Head All Purposes.	Unaccounted for.	Per Head Domestic.	Per Head Industrial	Per Head Other Purposes.	Per Head All Purposes.	Unaccounted for.
	Edmonton.					Lethbridge.					Medicine Hat.					Redcliff.				
1915	46·0	31·0	3·0	80·0		81·4	32·2	1·5	115·1		181	28	15	224		31·1	6·8		37·9	
1916	52·5	20·7	5·7	78·9		116·0	41·3	0·7	158·0		214			214		36·8	22·1	1·0	59·9	
1917	56·3	25·0	9·7	91·0		95·0	55·0		150·0		257			257		42·5	30·3		72·8	
1918	58·0	26·2	10·1	94·3		102·2	44·7	3·0	149·9					264		66·4	22·4		88·8	
1919	56·7	24·6	9·7	91·7		78·1	26·9		107·3					234		79·1	13·7		92·8	
	Stettler.					Claresholm.					Bassano.					Athabaska.				
1915						37·4		8·2	45·6		6·5	60·2		66·7		14·3			14·3	
1916						43·4		9·6	53·0							10·9			10·9	
9917	12·0			12·0		56·9	1·9	0·1	58·9		17·9	154·3	95·4	267·6		24·0			24·0	
1918	10·7			10·7		72·6	8·7	5·5	86·8					211·0		27·6			27·6	
1119				10·4										194·7		26·1			26·1	
	Carmangay.																			
1915	41·9		2·0	43·9																
1916	32·6			32·6																
1917	31·3			31·3																
1918	29·8		1·0	30·8																
1919	32·5		1·2	33·7																

SASKATCHEWAN.

Year.	Per Head Domestic.	Per Head Industrial.	Per Head Other Purposes.	Per Head All Purposes.	Unaccounted for.	Per Head Domestic.	Per Head Industrial.	Per Head Other Purposes.	Per Head All Purposes.	Unaccounted for.	Per Head Domestic.	Per Head Industrial.	Per Head Other Purposes.	Per Head All Purposes.	Unaccounted for.	Per Head Domestic.	Per Head Industrial	Per Head Other Purposes.	Per Head All Purposes.	Unaccounted for.
	Regina.					Saskatoon.					Moosejaw.					North Battleford.				
1915	55·0	7·5	0·1	62·6		21·6	13·9	2·2	45·6	7·9	24·1	4·6		28·7		6·6	1·3	2·7	14·8	4·2
1916	61·1	7·8		68·9		21·0	15·4	1·9	52·6	14·3	35·2	12·3		47·5		9·5	2·0	4·9	22·7	6·3
1917	59·2	12·6	0·3	72·1		24·4	15·6	5·8	66·4	20·6	45·8	13·1		58·9		10·2	2·2	4·0	23·1	6·7
1918	56·9	11·1	0·1	68·1		27·1	17·2	2·4	63·1	16·4	31·6	15·4		47·0		10·0	4·8	3·0	26·3	8·5
1919	42·8	8·3		51·2		28·0	16·3	1·9	64·1	17·9	24·8	15·1		39·9		11·5	1·6	4·4	29·7	12·2
	Weyburn.					Estevan.					Kamsack.					Battleford.				
1915	17·4		0·4	17·8		9·5	7·1	1·5	18·1											
1916	16·9		0·3	17·2		8·2	5·7	1·0	14·9											
1917	30·1			30·1		9·7	5·5	4·3	19·5							17·3			17·3	
1918	26·4			26·4		9·3	0·7	7·2	17·2		31·6	66·3		97·9		8·5			8·5	
1919	25·5			25·5		9·6	2·9		12·5							14·8			14·8	
	Kindersley.																			
1915	4·9	8·4	1·6	14·9																
1916	5·5	26·8		32·3																
1917	5·8	44·4		50·2																
1918	6·0	8·9		14·9																
1919	7·8			7·8																

WESTERN SECTION, CANADIAN PACIFIC RAILWAY IRRIGATION BLOCK

The remarks made in the 1918 report regarding the Western Section are equally applicable this year. The demand for water was the heaviest in the history of the project and many farmers demanded water this year for land which has not been watered for many years. This required considerable work on the company's part in reopening small ditches which had fallen into bad repair through disuse. Somewhat more than 80 per cent of the total length of all the canals and laterals in the system was operated during the season in order to make the required deliveries of water. In addition to the work referred to above the company carried out their regular routine of making improvements to the system wherever these seemed to be necessary or desirable. This work was considerably interfered with by the shortage of labour throughout the season and by the very early freeze-up in October.

Figures submitted by the company covering the whole of this section show that 31,908 acres were irrigated during the season.

EASTERN SECTION, CANADIAN PACIFIC RAILWAY IRRIGATION BLOCK

No new construction work of any magnitude was done in this section during 1919, although a good deal of work was done in repairing and enlarging existing ditches, especially in the Bassano and Patricia districts where the constructed laterals were considerably enlarged. At Brooks the main lateral which waters the land in the immediate vicinity of town was enlarged and extended.

A pumping plant was installed on the Canadian Pacific Railway land immediately west of town, which, obtaining water from the last-mentioned ditch, raises it some twenty feet and distributes it throughout the town of Brooks for the use of truck gardens, trees, etc. Previous to the installation of this plant no water was available for irrigation purposes in the Brooks townsite.

There still remains a considerable block of land in this section which has not yet been finally classified by the department and no further progress in this connection was made during the year. The company sold a great deal of land last year, and has now disposed of practically all of the irrigable land already classified which is closest to the railways already constructed.

The season of 1919 was dry and hot, being quite similar to 1918. The demand for water was heavy and consistent. Very good crops were obtained in the Bassano and Duchess districts. Gratifying results were obtained in the growing of alfalfa and clover seed, some almost phenomenal yields being obtained. On the dry lands very little grain was grown, the crops in many instances being total failures. The St. Julian Colony, lying south of Tilly, was again farmed by the company which employed a large staff of irrigators and had some very good returns. A certain area is being seeded to alfalfa on each of these farms. Figures submitted by the company covering the whole of this section show that 43,460 acres were irrigated during the season as against 24,440 acres in 1918.

ALBERTA RAILWAY AND IRRIGATION COMPANY

This company is controlled by the Canadian Pacific Railway Company, and its irrigated tract is commonly referred to as the Canadian Pacific Railway Lethbridge Section. The city of Lethbridge is the centre to which the irrigated land is tributary.

The season was again very dry in this district and there was a heavy demand for water which could not be fully met by the company. From about July 10 to October 15 the main canal was diverting practically the whole available flow of the St. Mary river, and during August and September, the total available flow of the river was not sufficient to meet the demands. Owing to the fact that the company's operating staff showed good judgment in dividing or rotating the available supply there was not

much general ground for complaint by the water users. Most of the crops received sufficient water so that they did not suffer greatly. Very little water, however, was stored in the Chin reservoirs for the supply of the Taber Irrigation district next year. The time has come when in order to ensure themselves of a sufficient supply of water in every season the company should construct a reservoir at one of the several sites existing which command all of the irrigable land.

The company carried out a considerable amount of improvement work on the system during the season. The largest undertaking, which was about 75 per cent completed when inspected was the replacing of the old wood diversion works at Magrath by a new reinforced concrete structure. In addition to this the intake to the main canal at Kimball was lowered two feet in order to increase the diversion capacity and several timber drops were built in natural channels, which are used as canals, to stop erosion. The enlargement of Chin No. 1 canal was continued during the year and completed all but about five miles.

The very hot season which was experienced produced probably the best alfalfa crop that has ever been harvested in the district, and with the extraordinary high price that was received for the crop, every alfalfa field was a veritable bonanza to the owner. It can be said, without any fear of contradiction, that this irrigated district, particularly the Coaldale district east of Lethbridge, is the most prosperous agricultural district in Alberta, and probably in any of the three Prairie Provinces. To any one driving through this district in the autumn of any recent year, the encircling vista of stack after stack of alfalfa or some other hay crop, indicates that the obvious reason for this great prosperity is the stabilizing of the agricultural industry by the production of forage crops over a comparatively large area.

Figures submitted by the company covering the whole of this section show that 71,969 acres were irrigated during the season. This shows a small increase over the preceding year.

THE CANADA LAND AND IRRIGATION COMPANY

During the summer the company carried on a good deal of miscellaneous construction work, designed to create a continuous capacity of not less than 400 c.f.s. throughout their main supply canal and reservoir system from the intake on the Bow river down to the Little Bow reservoir five miles southwest of Travers. This work included the building of several temporary wooden flumes, the construction of earthwork cut-offs to improve location, the strengthening of earth embankments through the lower portion of the Little Bow section and the construction of additional spillways.

The company will first put on the market the irrigable land in its Western Section and the canal capacity mentioned above will be sufficient to provide for this land. It plans to prepare certain lands for irrigation and alfalfa culture before they are sold. A good deal of work was done during the summer in carrying out this plan, mainly in the vicinity of Vauxhall, the headquarters for the Western Section.

During 1918 the main canal was operated down to Lake Macgregor reservoir and records now available show that 13,563 acre-feet were delivered into it. At the end of the season the reservoir had been filled up nearly to the elevation of the outlet gates at the south dam and it was expected that water would be drawn off from the reservoir early in the spring of 1919. This expectation was not realized, however, because it was found that some high ground existed in the bottom of the reservoir, near the south end, and the water had to be raised several feet before it ran down to the outlet gates.

During the season of 1919, 82,170 acre-feet were delivered into Lake MacGregor reservoir through the main canal, which was operated with some stops for repairs from April 19 to October 24. The rate of delivery varied up to maximum of 415 c.f.s. with an average for the season of 238 c.f.s. There is now a good head of water at the outlet gates for operation during 1920.

The water reached the outlet gates at the south dam on September 11 and a small flow was immediately carried on through the main canal for the purpose of *"priming"* the Little Bow section. This work was carried on with ordinary interruptions until October 25 when the water had reached *"mile eleven"* below the south dam. On this date there was a serious break near *"mile nine"* where a high fill slid out and the water had to be turned out of the canal. The work of repairing this break has been carried on during the winter, and while it has not been inspected, it is understood that the repairs have been made satisfactorily and that the canal will be ready for operation in the early spring of 1920.

Speaking generally of the whole main canal, there are a good many points of weakness, due to faulty original location, which will probably cause considerable difficulty in operating the canal for a number of years. The company is now, however, under very efficient management, which gives assurance that wise and energetic action will be taken to overcome such difficulties as may arise.

During the year a small party under Mr. V. Meek was engaged in classifying the irrigable land which the company intends to first put on the market in the Western Section. This work was very carefully done and included a soil survey of the area covered. The gross area inspected was 37,628 acres, of which 75 per cent, or 27,919 acres, was classified as irrigable. The work covered the period from June 24 to November 12 and cost five cents per gross acre and seven cents per irrigable acre.

COALDALE-LETHBRIDGE WATER USERS ASSOCIATION

The report published for 1918-19 gives a brief account of the development of this association and of the work accomplished up to the spring of 1919. It is pleasing to note that, as a result of the activity of this association, one Water Users District has actually been erected and one other has completed all necessary formalities save holding the actual election. The Coaldale Water Users District was erected under the Alberta Irrigation Districts Act on February 3, 1920. The notice of application for erection of the East Lethbridge Water Users District (formerly referred to as the North Lethbridge Water Users District) was published in the *Alberta Gazette* on February 14, 1920.

IRRIGATION DEVELOPMENT ASSOCIATION

This association was maintained quite actively throughout the year and continued the work of acting as a central bureau for all activities in connection with further irrigation development. It is rather difficult to describe just what work was done because, as a rule, its function was to father the first activity in a certain district and then, later on, when matters became advanced, the district would usually form its own separate organization to look after its own special interests. The association has done a great deal of useful work in starting the movement of forming irrigation districts and particularly in keeping all the different districts or organizations working as far as possible along the same lines. It is obvious that, in this matter of keeping the general interests of the south country co-ordinated, the association has a field for further very useful work, for many years to come.

It is fitting in dealing with this association to note the trip through the irrigated districts of Southern Alberta which was made by the Hon. Arthur Meighen, Minister of the Interior, in company with Hon. James A. Calder, Minister of Immigration and Colonization. The trip, which was made during the last week in August, included visits to Medicine Hat, Calgary, Macleod and Lethbridge at which place a large meeting of irrigation farmers was addressed by both the ministers. This trip was very much appreciated by the large number of people in Southern Alberta to whom the question of irrigation development was the one great issue of the year.

TABER IRRIGATION DISTRICT

After the meeting held in Taber on February 11, 1919, which was referred to in last year's report, negotiations were reopened between the trustees of the district and the Canadian Pacific Railway Company with a view to getting the actual construction of works executed during the year. By the end of March the preliminary negotiations were fairly well advanced, and by the end of April the company had submitted to the trustees a second proposed agreement. On May 15, copies of the proposed agreement were submitted to the department, and on June 12 were approved by the minister, subject to certain minor alterations. The agreement was finally approved by the minister on July 18, and on or about July 30, the land owners in the district voted unanimously in favour of issuing debenture bonds to cover the cost of construction of the works.

The agreement referred to above was founded on an acceptance of these facts. The district could be developed only as an extension of the Canadian Pacific Railway Lethbridge Section (Alberta Railway and Irrigation Company) and the company alone had the engineering force available to properly design and supervise construction of the works. The agreement was roughly this: The district would issue bonds and the company would construct the works and turn them over to the district, taking the district bonds in payment. The company also would undertake to furnish the district with a supply of water. The construction cost of the works per irrigable acre was fixed at sixteen dollars and the cost per season for the water at fifty cents per irrigable acre.

The company let a contract for the work as soon as possible after arrangements had been completed with the district and the job was started on July 24. The summer season was not favourable for moving dirt because the ground was so dry. Snowstorms coming on unexpectedly early caused the sub-contractors to start leaving the job on October 21 and by November 18 they had all stopped work, with one exception. The timber contractors worked until January 15, 1920. Very satisfactory progress was made during the short time available for work, and the job is now more than fifty per cent completed.

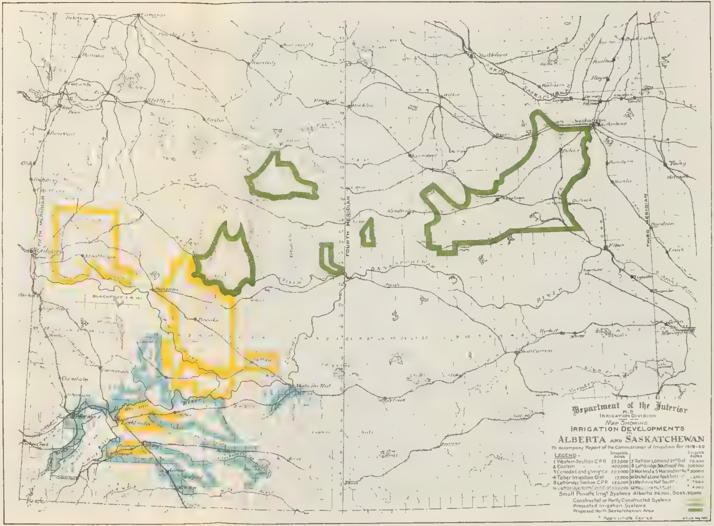
As this report is being written (April 20, 1920) the contractors have started in again on the work, although it is now too wet to make much headway with the earthwork. If the work progresses favourably the ditch may be ready to carry water on Dominion Day, 1920.

LETHBRIDGE NORTHERN IRRIGATION DISTRICT

In the last published report dealing with the Lethbridge Northern Project, it was stated that, at a meeting held at Lethbridge on March 27, 1919, it was decided to go ahead immediately and form an irrigation district. This work was actively carried on by "Locals" organized under the Irrigation Development Association and the first two petitions for the formation of the district were signed up and forwarded into the association headquarters at Lethbridge by May 21. The work of completing all petitions was carried on as actively as possible, and on July 14 all the petitions were submitted to the Minister of Public Works at Edmonton. During this period one of the most interesting developments was the attendance at a meeting at Twelve Mile Coulee schoolhouse on June 27 of a delegation from the Barons-Carmangay District giving notice that the people whom they represented wanted to be included in the proposed irrigation district.

The district was advertised in the *Alberta Gazette* of July 31, and the vote for erection was taken on September 20 and carried almost unanimously. The district was formally erected on October 23 with the following three trustees: T. W. Crofts, of Commerce; George Chew, of Barons; and H. W. Lever, of Coalhurst.

The Government of Alberta employed Mr. George G. Anderson as consulting engineer who submitted a report on the district to the Government dated January 17, 1920, at Edmonton.



Department of the Interior
R.S
IRRIGATION DIVISION
MAP SHOWING
IRRIGATION DEVELOPMENTS
IN
ALBERTA AND SASKATCHEWAN
To accompany Report of the Commissioner of Irrigation for 1919-20
LEGEND -
Irrigable Acres
1 Western Section C.P.R. 223,000
2 Eastern 400,000
3 Canada Land & Irrig. Co. 203000
4 Taber Irrigation Dist. 17,000
5 Lethbridge Section C.P.R. 120,000
7 Retlaw-Lomond Irr. Dist. 70,000
8 Lethbridge Southeast Pro. 350000
9 Macleod & S. Macleod Irr. Pro. *30000
11 Medicine Hat South 7000
Small Private Irrig. Systems Alberta 56,700, Sask. 30,000
Constructed or Partly Constructed Systems
Projected Irrigation Systems
Proposed North Saskatchewan Area
Saskatoon
Battleford
Calgary
Red Deer
Lethbridge
Medicine Hat
Swift Current
Kindersley
Rosetown
Outlook
Castor
Stettler
Brooks
Bassano
Strathmore
Claresholm
Macleod
FOURTH MERIDIAN
THIRD MERIDIAN
FIFTH MERIDIAN
BLACKFOOT I.R.

During the last assembly of the Alberta Legislature a large amount of discussion was devoted to the new Irrigation Districts Act, the Water Users' Districts Act and the proposal that the bonds of the Lethbridge Northern District should be fully guaranteed by the Alberta Government. The two Acts mentioned above were passed, but it was decided not to guarantee the bonds. Instead, a special Act was passed which provided for a specified sum of money, which might be used in meeting certain debts of the district in the event of default in payment by the district.

As this report is being written the trustees of the district are sitting as a court of revision and their intention has been announced of holding a vote on the issue of district bonds just as soon as possible. There are, however, a number of serious questions which have to be dealt with before much further progress is made. The question of enlarging the present boundaries of the district is one that requires serious consideration and that should be dealt with before the issue of bonds. The whole question of sale of bonds is made very difficult by the present state of the bond market which probably will not look too favourably upon Canadian irrigation bonds without a Government guarantee.

MACLEOD IRRIGATION PROJECTS

Three different projects, all in the vicinity of Macleod town, have been dealt with during the past few years, so that the name Macleod Irrigation Project has become rather confusing. The following short explanation may make the matter clear.

The first Macleod project which was surveyed in 1916 included some nine thousand five hundred irrigable acres lying directly south of Macleod. This area was to be irrigated by a branch from the main canal for the Lethbridge Northern Project, which was located out of the valley of the Oldman river on the south side. It is now proposed to include this area of land in the proposed South Macleod Irrigation District, which will be referred to under a separate heading.

During the summer and autumn of 1919, as definite steps were being taken by the Lethbridge Northern District towards early construction, the landowners in the district north of Macleod and north of the Oldman river became very active in demanding that they should receive a supply of water from the main canal for the Lethbridge Northern which ran through their lands. As a result, early in 1920, petitions were circulated and signed for the purpose of forming the land in township 9, range 26—township 9, range 25—and township 10, range 25, which lies below the main canal, into an irrigation district. This was spoken of as the North Macleod Irrigation District. The original proposal was to come to an agreement with the Lethbridge Northern District for a supply of water. The most recent development has changed this plan to what is the more desirable one of endeavouring to have the boundaries of the Lethbridge Northern District enlarged so as to include this area of land.

SOUTH MACLEOD IRRIGATION DISTRICT

Our report of last year referred to this proposed irrigation district as follows: "The active interest in irrigation during the winter (1918-19), included the landowners in the strip of smooth country lying south of Macleod between the rough breaks of the Ridge Between the Rivers and the Waterton and Belly rivers and running to a point near Ewelme. The irrigation of this area contemplates a diversion from the Waterton river, either direct or from the Belly river through the works of the United Irrigation District. A very brief reconnaissance was made in the field during the winter and it is probable that a direct diversion would be very difficult and expensive. It has always been stated that it is feasible to tap the Oldman river at Brocket, run down to a mile south of Chokio and then by taking advantage of a depression in the country, bring a canal through the Ridge Between the Rivers and thus command all the irrigable area lying to the south of Macleod."

Unfortunately it was not found possible to complete the investigations in connection with this project during the field season, but some instrumental survey work was done and also some further reconnaissance work. The further and more careful reconnaissance work done, developed a better location out of the Waterton river and while this point remains to be settled by actual surveys, it is now thought that it will be feasible and economical to divert direct out of the Waterton to serve this project. An eye reconnaissance in connection with the suggested diversion from the Oldman river near Brocket indicated that this would not be feasible, or at any rate not so economical as a diversion from the Waterton river. The landowners in the proposed district are strongly in favour of a diversion from the Waterton and considerable assistance was given in making this reconnaissance by some of the landowners who were familiar with the district.

The boundaries of the proposed district have been outlined by the interested landowners for lands to be irrigated by direct diversion from the Waterton river. The petitions for the erection of the district were circulated and signed during the winter and submitted to the Provincial Government on March 25, 1920.

BARONS-CARMANGAY IRRIGATION DISTRICT

The stimulation of interest in this district followed much the same lines as recounted above in connection with the district north of the Oldman river referred to in connection with the Macleod irrigation projects. There was some opposition to the proposed formation of this irrigation district, but finally, after some alteration of boundaries, particularly in the vicinity of Carmangay town, petitions were signed up and submitted to the Provincial Government on January 17, 1920. No official action has been taken as yet towards the erection of this area into an irrigation district. It is now understood that later, plans to enlarge the boundaries of the Lethbridge Northern District to include this area were adversely voted upon by the interested parties.

SOUTHERN IRRIGATION DISTRICT

This district was referred to in last year's report as the Magrath-Raymond-Stirling Irrigation District, which gave a geographic indication of the area included in the district. Petitions for the erection of this district were circulated during the early autumn and finally signed up and submitted to the Provincial Government in October, 1919. The notice of the application to form an irrigation district was published in the *Alberta Gazette* of January 15, 1920. The district was erected by order dated March 16, 1920, which named H. S. Allen, of Raymond, A. E. Fawns, of Stirling, and C. Jensen, of Magrath, as the trustees of the district.

As indicated in last year's report this district is already partially served by the Alberta Railway and Irrigation Company's system. The idea of forming the district is to gain a water supply for those lands not now served by the company's canal system. The fact that this district will include all those lands which have already been successfully irrigated under the company's canal for many years entirely removes that ordinarily very difficult feature in development of this kind—the human element—and gives the greatest possible assurance that the district will be successful when developed.

NEW DAYTON IRRIGATION DISTRICT

This proposed district comprises practically all the land in Tract 7 A of the proposed Lethbridge Southeast Project, but with the land at the east end of range 15 omitted. The west end of the district meets the east end of the Southern Irrigation District. The petitions for the erection of the district were circulated and signed during the winter and submitted to Edmonton on April 30, 1920.

WARNER-MILK RIVER IRRIGATION DISTRICT

The area within this proposed district comprises practically all the land in Tract 8 of the Lethbridge Southeast Project and is all commanded by the canal already constructed (but not used) by the Alberta Railway and Irrigation Company and planned to divert water out of Milk river. The petitions for the erection of this district have been circulated and largely signed. Owing to the absence of some of the owners there are some signatures which may yet be obtained, and on account of this fact and some other details the petition has not been submitted to the Provincial Government.

LETHBRIDGE NORTHERN PROJECT, RETLAW-LOMOND DISTRICT

Mr. T. M. Montague, who has charge of the survey of this project during 1919, has submitted a full report of the field-work, which, however, will not be published. the following is a summary covering this development.

Preliminary surveys were made in the fall of 1914 to determine the possibility of diverting water from the Southern Alberta Land Company's system for certain lands in ranges 17, 18, 19, and 20, east of the Little Bow river, and between that river and the block of land owned by the above company. The name of the company has since been changed to the Canada Land and Irrigation Company. This work was reported in our 1915 report under the caption "Sundial Water Supply and Irrigation Project."

The primary object of these surveys was to determine some feasible system of canals to serve this area with water for domestic and stock-watering purposes, utilizing as far as possible natural channels. Sufficient data were obtained to show that approximately 93,700 acres of land which would be greatly benefited by irrigation could be commanded by a system of canals if the necessary amount of water is available. Further investigations made the following year by Mr. V. Meek, who had charge of the surveys of the Lethbridge Northern Irrigation Project, determined the possibility of extending that project across the Little Bow river to serve these lands.

An approximate estimate of cost based on the surveys made in 1914 and 1915 was completed in 1918 (and published in our report for 1918-19) for a scheme to irrigate a maximum of forty acres to a quarter-section. A scheme of this sort which would benefit a large area of country to the extent of forty acres of irrigable land to a quarter-section and allow a greater number of settlers sufficient water for the cultivation of feed for stock, would it was thought, meet with the approval of the majority of settlers in the district.

Mr. T. M. Montague was instructed to make a detailed survey of the irrigable lands in this district based on the forty-acre basis, and to locate the necessary supply canals from the proposed Lethbridge Northern Project. His party took the field about the beginning of June and after outfitting at Carmangay moved camp to the Little Bow river on June 6, where actual field operations were commenced. During the working season of 122 days between June 6, 1919, and November 15, 1919, when the party was disbanded on account of the severe weather and heavy snows, this party ran 177 miles of survey for main canals, 280 miles for distributaries, 34 miles for drainage canals, 25 miles of flying levels and 257 miles of stadia levels. Forty-two soil samples were taken. The party consisted of thirteen men, and the transport consisted of ten horses, one wagon and three democrats.

As stated, the surveys were based on providing water for a maximum of forty acres in any one quarter-section and all canals were designed and located on this basis. An approximate estimate of the total irrigable area in each quarter-section was also made. The only feature in this scheme involving any difficult engineering problem is the crossing of the valley of the Little Bow river. At the proposed crossing the distance from grade to grade is 6,100 feet and the depth of the valley below the

hydraulic grade line is 225 feet. An inverted syphon will be required to carry the water across the valley and will be supported across the river proper by a truss from 300 to 400 feet in length.

The surface throughout most of the irrigable area is smooth and the slopes light. In portions of the district such as the east half of township 12, range 17, the slope is not sufficient for irrigation. Over considerable areas in the district the question of sufficient drainage is a difficult one and the necessary expense of constructing main drainage outlets will add considerably to the cost of the project. The soil varies from a sandy loam to a light clay loam and in some locations consists of clay. The subsoil is sand and clay.

The field-work was all completed during the season except what is required for that district lying between the area reserved for the Canada Land and Irrigation Company and the Bow river in townships 14 and 15, range 16. The party had just moved to this district when the early snowstorms made it necessary to stop the work. Unfortunately Mr. Montague resigned during the winter and owing to lack of assistance it has not been possible during the winter to do more than complete part of the plans. No schedule has been completed showing the total irrigable areas nor has any estimate of cost been made. Preliminary figures taken off indicate that on the forty-acre basis as surveyed the total irrigable area will be about 58,000 acres and if all land possible were irrigated the total would be about 100,000 acres.

LETHBRIDGE SOUTHEAST PROJECT

Mr. H. D. St. A. Smith was in charge of the plane-table surveys which were made and has submitted a complete report. This report will not be published however, but the following gives a short summary of the work executed.

Mr. Smith was instructed to make careful plane-table surveys of the tract of land between Verdigris coulee and the supply canal from Milk river, partially constructed by the Alberta Railway and Irrigation Company some years ago. (Tract 8 of the Lethbridge Southeast Project, which it is now proposed to erect into the Warner-Milk River Irrigation District.) These surveys were to be of such a nature that an accurate classification of the irrigable acreage in each quarter-section of land could be made and an office projection of the distributary canals completed. The aim was to get such complete information by this survey that no further field-work would be necessary until such time as actual construction surveys were necessary.

It was originally intended to put into the field on this work, two parties of three plane-tables, each consisting of fifteen men. Because of the lack of qualified men to take charge it was decided to combine these two parties under Mr. Smith. The transport for this party consisted of one Ford one-ton truck, two Ford touring cars and two Fords with open delivery bodies. The party was assembled at Warner on July 19, 1919, and actual field-work commenced on July 22. Field-work was discontinued on October 21, 1919, on account of the severe weather and heavy snows. The number of plane-table days completed by this party was 294. During this time the party ran 211 miles of levels establishing temporary bench-marks at every quarter-section corner, made plane-table surveys of 340 quarter-sections, representing a total of 54,880 acres of land. They also ran eighteen miles of traverse for secondary canals and established one permanent iron bench-mark. Eight miles of traverse for a canal from the Milk River reservoir to lands south of New Dayton had been run when the work was discontinued on account of the severe weather.

Mr. P. A. Fetterly was attached to this party in charge of the field classification of lands and as each quarter-section was surveyed it was gone over in the field by him and classified as irrigable or non-irrigable, depending on its adaptability to the application of water. The instructions were to classify "hard," that is, all doubtful land was to be classed as non-irrigable.

This area is practically the lower slope of the Milk River Ridge. The surface is rolling and rather rougher than is the case with most tracts of irrigable lands. The area as a whole, however, will require a very small amount of concentrated cost except in the case of drop lines. It was found that a comparatively large area of each quarter-section could be put under irrigation with very little double fill or levee. The surface soil generally is a light clay loam with a subsoil of heavy clay loam to clay and hard-pan in the lower lying lands. In the upper lands, and especially in the vicinity of Warner, the surface is sandy loam and as a rule the subsoil is heavy. The possibilities of drainage are exceptionally good owing to the network of natural watercourses which run to Verdigris coulee.

Mr. I. R. Strome was in charge of a field survey party which was employed in running an improved location for the main supply canal between the Belly and the St. Mary rivers and completing surveys of reservoirs sites at Taylorville and Lumpy Butte. Mr. Strome has submitted a full report but only the following summary will be published.

This party was assembled at Cardston and moved to the NE. ¼ of section 27, township 2, range 24, West 4th meridian, on July 22, 1919, where actual field-operations were commenced. This party consisted of eleven men and the transport was one Ford touring car, one Ford with open delivery body and one Ford one-ton truck. The party commenced field operations on July 22, 1919, and was disbanded on November 10, 1919. About another week was spent by Mr. Strome and several assistants in running some necessary levels and taking topography. Considerable time was lost on account of bad weather, and the number of days actually worked was 78. During this time the party ran 98.6 miles of traverse with profile and topography, 28.2 miles of traverse with profile only, 45 miles of preliminary levels, 123 miles of check levels, made 40 land ties, completed contour surveys of reservoir sites over 2,000 acres and established 8 permanent bench-marks.

During the winter the large plans in connection with this work were plotted and a projection made for the relocated main canal between the Belly and the St. Mary rivers.

In the year 1914 a preliminary survey was made of the proposed dam site on the St. Mary river in section 4, township 1, range 25, West 4th meridian, and a contour survey made of the reservoir site. Since the proposed dam at this site is one of the important features of the project it was considered advisable to make a very detailed survey of the site and complete the investigation by making test borings of the foundations. Mr. B. Russell with two assistants made this survey. The work was commenced on November 1, and completed on November 6, 1919. The survey was made entirely by stadia and all rock outcrops were accurately located and a section developed. A plan of this survey has been placed on file. The plan numbers of the original plan and tracing are respectively 27-A and 27-B. Test borings are being made of the foundations at the present time so that upon the completion of this work it will be possible to estimate the cost of this structure and determine definitely the feasibility of diverting the St. Mary river at this point.

Upon the completion of the St. Mary river dam site survey Mr. Russell also made surveys of dam sites at the Waterton lakes. These surveys were commenced on November 10, and completed on November 14, 1919. In making estimates of the available water supply from the Waterton river it has always been considered that it would be possible to store five or six feet in the Upper Waterton lake without damaging the park and the amount of water considered available was estimated on that basis. By constructing a high dam at the "Narrows" on the Upper Waterton lake it would be possible to store a very large quantity of water and make it feasible to divert and put to beneficial use a large percentage of the flow of the Waterton river. The additional storage would be of enormous commercial value. Two dam sites were developed and plans have been placed on file.

UNITED AND LONE ROCK PROJECTS

Authorization was given to the Alberta Stake of Zion (The Mormon Church in Alberta) on May 25, 1907, to divert water from the Waterton river at the NE. ¼ section 13, township 3, range 28, west 4th meridian, for the irrigation of certain lands between the Waterton and Belly rivers in townships 3, 4 and 5. From the preliminary surveys which were made at that time it was determined that the cost of diverting from the Waterton river would be too great, and authorization for construction was cancelled on September 28, 1910. The idea of diverting from the Belly river instead of the Waterton was later conceived and a reconnaissance made by this office at the request of some local farmers proved such a scheme to be quite feasible. During the summer of 1918 the farmers in this district, having very poor crops, decided without authority from the department to go ahead with the grading of the main canal of this scheme. Only a very small amount of the work was completed when it had to be abandoned on account of the influenza epidemic.

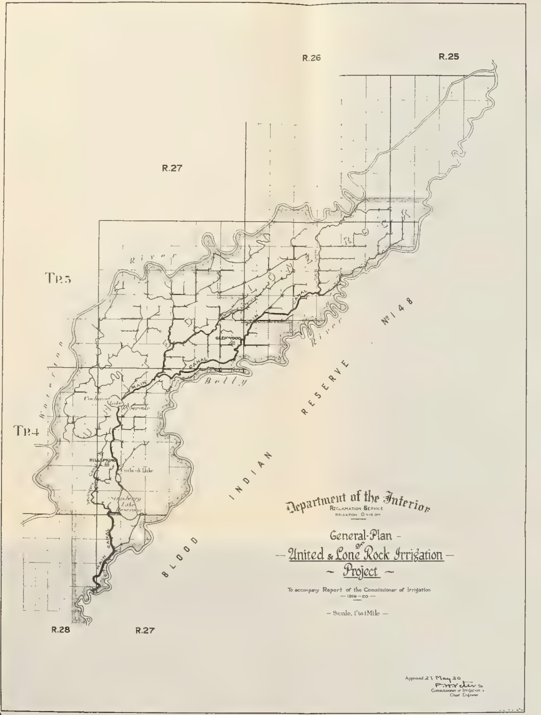
The department was authorized to make complete surveys of this project in the year 1919 and Mr. N. M. Sutherland was placed in charge of the work. The party was organized at Cardston on July 16 and moved to the Belly river, section 13, township 3, range 2, West 48th meridian on July 18 where actual field-work was commenced on July 21, 1919. The party consisted of thirteen men, and the transport of two democrats, one wagon and nine horses.

Mr. Sutherland was instructed to make a complete survey of the United Irrigation District, including an extension to serve the Lone Rock District, and later on to make complete surveys of the South Macleod District, provided it were found from a reconnaissance that it was feasible to irrigate the lands in this district. Between July 21 and November 12, 1919, the duration of the field season, the actual number of working days completed by the party was 91. During this time the party ran 131 miles of levels, 92 miles of traverse for the main canal, 80 miles of traverse for distributary canals and 89 miles of check levels. Three permanent iron bench-marks were established by the party.

It is difficult to give any brief description of the surface of these districts which will convey any idea of their character. The fact that the United and Lone Rock districts consist of a comparatively narrow strip of land between two large streams, the Belly and the Waterton rivers, and lie close to the mountains will, however, in itself suggest very irregular and steep slopes. Not only is the surface irregular and cut up by small watercourses but the whole area has a heavy fall to the northeast. An idea of the general slope of the country may be gained from the fact that the Belly river has a fall of approximately forty feet to the mile through township 3, where the proposed intake is located.

Although this heavy slope makes the distributary system comparatively expensive, due to the necessity of providing drop lines, it has one decided advantage in that it makes it possible to get out of the river valley with a remarkably short length of main canal. The actual length of the main canal from the intake to the first delivery as located by Mr. Sutherland is about 1.5 miles. One peculiar topographical feature of the district is the existence of a number of shallow coulees which parallel the rivers for considerable distances. The existence of these coulees has a bearing on the design and cost of any irrigation system. For a scheme embracing a small area of land requiring small quantities of water quite a number of miles of canal can be saved by turning water freely into these natural channels and conveying it through the district by this means. For a larger scheme, however, these coulees are too steep to be taken advantage of to this extent and in order to safely carry the water a great number of drops have to be provided. Throughout the district there are several small lakes in which it is possible to store small quantities of water.

The character of the soil throughout the United and Lone Rock districts like the surface, is variable. There is considerable gravel throughout. Most of the ridges



R.26
R.25
R.27
Tp.5
Tp.4
River
Belly
River
MAIN CANAL
GLENWOOD
HILLSPRING
Cochrane Lake Reservoir
Strawberry Lake Reservoir
BLOOD INDIAN RESERVE
No. 148
R.28
R.27
Department of the Interior
Reclamation Service
Irrigation Division
General Plan
of
United & Lone Rock Irrigation
Project
To accompany Report of the Commissioner of Irrigation
1919–20
Scale, 1" to 1 Mile
Approved 21 May 20
P. M. Peters
Commissioner of Irrigation & Chief Engineer

are gravel and there is a considerable amount along the rivers. The surface soil varies from a light clay loam at the south end of the United District to a loam, and possibly sandy loam, toward the north of the Lone Rock District.

Mr. Sutherland's instructions upon commencing field-work in regard to the South Macleod Project were to first run sufficient levels to determine the most feasible source of water supply, and then, if it were found feasible to irrigate lands in the South Macleod District either from the Waterton or from the Belly rivers, he was to make the necessary preliminary surveys of the project. In order to speed up the work it was later found advisable to send out a small party to run the necessary levels over the South Macleod Project. Mr. G. E. Vrooman, with two assistants and a Ford car, was put in the field to do this work. Mr. Vrooman's instructions were to run levels over all section lines, placing semi-permanent bench-marks at all section corners and permanent iron bench-marks at all township corners, or at more convenient section corners six miles apart. The location of all intermediate points were to be located by pacing. Mr. Vrooman commenced work on September 15, 1919, and completed the system of levels as instructed. Only a portion of the main canal to this district was run by Mr. Sutherland before field-work was discontinued on account of the severe weather.

During the winter a complete set of plans was prepared and traced showing the system proposed to be constructed to irrigate 14,392 acres in the United District and 8,621 acres in the Lone Rock District, and an estimate of the cost of construction has been prepared. Owing to the fact that a number of features in connection with this proposed development have not as yet been finally decided, the estimate is not being published in this report.

NORTH SASKATCHEWAN DIVERSION PROJECT

This project has been repeatedly brought to the attention of the department by Mr. William Pearce, of Calgary, who takes a very broad and advanced view of the proposed development. His conception is of a great area, which while not commonly so considered, is really in a dry belt where natural hay crops cannot be successfully raised and where the natural surface water supply is inefficient to support that amount of live-stock which properly should be kept on the farm lands. The lack of ability to keep the necessary amount of live-stock is very properly conceived to create a serious difficulty in establishing agriculture on a permanent basis. Mr. Pearce's idea is to carry an artificial supply of water through the great area, which will be outlined hereunder, and distribute it primarily for the purpose of establishing the stock industry. This means not only the supply of water for drinking purposes but also a sufficient supply of irrigation water to create both summer pasture and enough hay to carry through the winter.

The first preliminary report on this project was prepared by the commissioner on August 17, 1915. During 1919 a general but hurried reconnaissance of the whole project was made by the commissioner, and local instrumental reconnaissances were made by Mr. B. Russell and Mr. A. E. Welby. A very large amount of instrumental survey will be required before this great project can be definitely developed and reported on. At the present time it is only possible to outline the general boundaries of the area involved and to indicate our present opinions which will be subject to correction when more information is available.

The proposal is to gain the main supply of water by tapping the North Saskatchewan and the Clearwater rivers near Rocky Mountain House. Probably the Red Deer, the Blindman and the Battle rivers could also be diverted and their waters utilized. The total available flow from all these sources from April to November is 5,800 000 acre-feet. It would be possible to maintain a continuous average flow for practically the whole of the eight months as above of 5,000 c.f.s. and this would supply

2,400,000 acre-feet during the season. The water from the original sources of supply would be diverted into Buffalo lake, which would be created the main reservoir with a possible maximum capacity of over 800,000 acre-feet.

The water would be drawn off from Buffalo lake at an elevation somewhat above 2,500 feet. Mr. Pearce's idea has been that all land below this elevation, to the east of the reservoir, and between the North Saskatchewan and the Red Deer and South Saskatchewan rivers should be supplied with water from this scheme. As a result of the reconnaissance referred to above the present feeling is rather that the area for development should be restricted to the area lying to the south of the railway line running from Coronation to Kerrobert, from Kerrobert to Doddsland, from Doddsland to Biggar, and from Biggar to Saskatoon. Even with this restriction an immense district is affected comprising a rectangle with dimensions of roughly 130 by 180 miles. The nearest edge of this area is about 200 miles from the most distant original source of supply, the North Saskatchewan river in township 39, range 9, west of the 5th meridian, and from this point it is about 350 miles as the crow flies to the lower end of the proposed area near Saskatoon.

As regards the general lay of the land and its suitability for irrigation, it is of course impossible to make any complete statements based on the comparatively small amount of reconnaissance work done. The general impression of the district is that main canal location may prove difficult because most of the drainage lines run at right angles to the general direction of the main supply canals. There are certain areas, particularly in the Berry Creek district, and again between Rosetown and Saskatoon, that appear to lie very nicely for irrigation. Again there appear to be other large areas which while smooth and otherwise suitable, have no natural drainage. In general the areas which appear to be smooth enough and generally suitable for irrigation are separated by long stretches of country too rough for irrigation.

Tentative schedules, which have been prepared, indicate that the gross acreage in the districts which appears to be suitable for irrigation is 2,900,000 acres. Assuming that forty per cent of this could actually be irrigated the net irrigable area would be 1,160,000 acres. There is no doubt that one hundred per cent irrigation is required for the Berry Creek district, and probably also for the area northeast of Youngstown. Speaking generally of the whole area the opinion is held that something along the line of the so called forty-acre tract proposition (or twenty-five per cent irrigation) for the purpose of growing hay, providing water for summer pasture and water for drinking purposes, would be desirable.

DUTY OF WATER AND IRRIGATED CROP REPORTS FOR 1919

The study of the question of the proper duty of water requires the collection of a great deal of detailed information and then a very careful study of all data available. A complete report containing all the data collected has been submitted separately, but owing to its bulk will not be published. This summary report outlines the scope of the work which was carried out and deals briefly with the more interesting features. Work at the Strathmore station was discontinued with the close of the 1918 season on account of the impossibility of securing reliable information regarding duty of water data due to the presence of the ground water table within three to four feet of the surface.

Experimental plot work was carried on at Brooks and Ronalane in the same manner as for 1918.

Data regarding the duty of water were collected at Coaldale and irrigated crop reports were submitted by the inspecting engineer for the Cypress Hills district, mainly in Saskatchewan, and for the Macleod district in Alberta.

The work was carried on under the general supervision of Mr. W. H. Snelson, Mr E. E. Eisenhauer collected the data in the Coaldale district. Mr. S. Hansen, of the Canada Land and Irrigation Company, operated the plots at Ronalane.

DUTY OF WATER PLOTS, RONALANE, ALBERTA, 1919

The grain and root crops were located upon a strip of land immediately west of the position which they occupied in 1918, in order to get away from the non-uniform conditions of soil fertility which were found to be present in the 1918 location.

The land occupied by the grain and root crops this season grew root crops in 1918. The plots were so arranged this season as to have a plot which received five four-inch irrigations at both the north and south ends of each plot series. The series were two plots wide and four plots long, running north and south. This arrangement, having a dry plot and a five four-inch irrigation lying parallel to each other with their ends abutting upon the main trail, furnished a striking contrast between what could be produced with twenty inches of water and what could be produced with no irrigation. The other five four-inch irrigation plot was located at the extreme south end of the plot series, and the yield from it was compared with the other plot at the north end of the series in order to note any differences in yield due solely to different conditions of soil fertility. In the above comparisons for each crop series, slight but consistent differences in yield were noted, the plots at the north end of the series yielding less per acre, in proportion to the amount of water which they received than did those at the south end of the series. The plot yields of each series were therefore adjusted to conform with this consistent variation in yield and the results given in the following tables are the corrected yields.

The alfalfa plots occupied the same location as in 1918.

The season of 1919 was another very dry one, the precipitation at Ronalane, April to September, inclusive, being but 6.82 inches, being but 2.23 inches greater than for the same period in 1918 and 0.82 inch greater than for the same period in 1917, both of which were very dry years. Comparison with Calgary records indicates that the past season with the exceptions of 1917 and 1918 was as dry as any that has been experienced since 1892. The evaporation and hot wind movement were quite similar to 1918. In general, the season was almost identical with 1918, having but a slightly greater precipitation and a mean summer temperature of 58.4° as compared with 56.8° for 1918.

In the alfalfa plots the best yield, 3.11 tons per acre, was produced with a total depth of water (irrigation plus precipitation) of 2.17 feet, 0.50 foot received as precipitation and 1.67 feet in five four-inch irrigations. As more water was applied the yield was decreased. The dry plot produced nothing.

The best wheat yield 39.5 bushels per acre, was produced with a total depth of 1.80 feet, and an increase in depth decreased the yield. The dry plot produced 10.5 bushels per acre.

The best oat yield, 77.2 bushels per acre, was produced with a total depth of 1.50 feet. Increased depth decreased the yield. The dry plot produced 10.9 bushels per acre.

The best barley yield, 56.0 bushels per acre, was produced with a total depth of 1.83 feet. Increased depth decreased the yield. The dry plot produced 6.1 bushels per acre.

The best yield of peas, 33.6 bushels per acre, was produced with a total depth of 2.50 feet, which was the maximum depth applied to the pea series. The dry plot produced 12.7 bushels per acre. The peas suffered quite extensively from mildew.

The best yield of potatoes 366.5 bushels per acre, was produced with a total depth of 2.26 feet. Increased depth decreased the yield. The dry plot produced 57.5 bushels per acre.

ALFALFA PLOTS, 1919.

Plot No.	Area. — Acres.	Irrigation. — Date and Depth Applied in Acre-feet per Acre. May.	June.				July.				August.		Duty of Water.	Rainfall April 1 to Harvest.	Total Depth Rec'd.	Used to Grow the Crop.	Yield in Tons per Acre.
		25	6	9	16	18	12	16	22	28	11	18					
1	0·25																
2	0·25					0·33	0·34						0·67	0·50	1·17	1·49	1·08
3	0·25			0·33			0·33				0·34		1·00	0·50	1·50	1·61	1·66
4	0·25			0·33			0·33			0·34	0·33		1·33	0·50	1·83	1·93	2·62
5	0·25		0·33				0·33			0·34	0·33	0·34	1·67	0·50	2·17	2·36	3·11
6	0·25	0·33			0·33		0·34	0·33			0·33	0·34	2·00	0·50	2·50	2·30	3·09
7	0·25	0·33		0·33			0·34	0·33	0·33	0·34	0·33	0·34	2·67	0·50	3·17	3·08	2·44
8	0·25			0·50			0·50				0·50	0·50	2·00	0·50	2·50	2·41	2·14
9	0·25			0·50			0·50				0·50	0·50	2·00	0·50	2·50	2·56	2·69
10	0·25			0·50			0·50	0·50		0·50	0·50	0·50	3·00	0·50	3·50	3·53	2·44

WHEAT (MARQUIS) 1919.

Plot No.	Area. — Acres.	Irrigation. — Date and Depth Applied in Acre-feet per Acre. June.				July.						August.			Duty of Water.	Rainfall April 1 to Harvest.	Total Depth Rec'd.	Used to Grow the Crop.	Yield per Acre.
		11	12	17	26	2	5	12	16	22	28	2	6	13					Bush.
19	0·25														0·00	0·47	0·47	0·80	10·5
21	0·25			0·33											0·33	0·47	0·80	0·98	25·6
22	0·25			0·33					0·34						0·67	0·47	1·14	1·01	25·9
23	0·25		0·33			0·33				0·34					1·00	0·47	1·47	1·27	37·0
24	0·25		0·33				0·33			0·34		0·33			1·33	0·47	1·80	1·68	39·5
25	0·25	0·33			0·33				0·34		0·34		0·33		1·67	0·47	2·14	2·03	39·5
26	0·25	0·33			0·33			0·34			0·33		0·33	0·34	2·00	0·47	2·47	2·30	36·4

OATS (ABUNDANCE) 1919.

Plot No.	Area. — Acres.	Irrigation. — Date and Depth Applied in Acre-feet per Acre.													Duty of Water.	Rainfall April 1 to Seeding.	Total Depth Rec'd.	Used to Grow the Crop.	Yield per Acre.
		June.				July.						August.							
		11	12	17	26	2	5	12	16	22	28	2	6	13					Bush.
27	0·25														0·00	0·47	0·47	0·43	10·9
29	0·25			0·33											0·33	0·50	0·83	1·01	49·8
30	0·25			0·33					0·34						0·67	0·50	1·17	1·07	65·1
31	0·25		0·33			0·33				0·34					1·00	0·50	1·50	1·32	77·2
32	0·25		0·33				0·33			0·34		0·33			1·33	0·50	1·83	1·56	73·7
33	0·25	0·33			0·33				0·34		0·33		0·34		1·67	0·50	2·17	1·89	76·1
34	0·25		0·33		0·33			0·34			0·33		0·34	0·34	2·00	0·50	2·50	2·23	67·4

BARLEY (BARK'S EXCELSIOR) 1919.

Plot No.	Area. — Acres.	Irrigation. — Date and Depth Applied in Acre-feet per Acre.												Duty of Water.	Rainfall April 1 to Harvest.	Total Depth Rec'd.	Used to Grow the Crop.	Yield per Acre.
		June.				July.					August.							
		11	12	17	26	2	12	16	22	28	2	6	13					Bush.
35	0·25													0·00	0·48	0·48	0·77	6·1
37	0·25			0·33										0·33	0·50	0·83	0·97	42·2
38	0·25			0·33				0·34						0·67	0·50	1·17	1·21	53·9
39	0·25		0·33			0·33			0·34					1·00	0·50	1·50	1·30	54·7
40	0·25		0·33			0·33			0 34		0·33			1·33	0·50	1·83	1·37	56·0
41	0·18			0·33	0·33			0·34		0·33		0·34		1·67	0·50	2·17	1·72	52·9
42	0·125	0·33			0·33		0·34			0·33		0·33	0·34	2·00	0·50	2·50	2·04	51·8

PEAS (CANADA BLUE) 1919.

Plot No.	Area. — Acres.	Irrigation. — Date and Depth Applied in Acre-feet per Acre. June. 12	June. 17	June. 26	July. 2	July. 5	July. 12	July. 16	July. 22	July. 28	August. 2	August. 6	August. 13	Duty of Water.	Rainfall April 1 to Harvest.	Total Depth Rec'd.	Used to Grow the Crop.	Yield per Acre.
																		Bush.
11	0·25													0·00	0·41	0·41	0·48	12·7
12	0·25																	
13	0·25		0·33											0·33	0·50	0·83	0·78	16·9
14	0·25		0·33					0·34						0·67	0·50	1·17	1·21	22·5
15	0·25	0·33			0·33				0·34					1·00	0·50	1·50	1·73	22·7
16	0·25	0·33				0·33			0·34		0·33			1·33	0·50	1·83	1·73	23·8
17	0·25	0·33		0·33				0·34		0·33		0·34		1·67	0·50	2·17	2·00	25·6
18	0·25	0·33		0·33			0·34			0·33		0·33	0·34	2·00	0·50	2·50	2·27	33·6

POTATOES (GOLD COIN) 1919.

Plot No.	Area. — Acres.	Irrigation. — Date and Depth Applied in Acre-feet per Acre. June. 17	June. 25	July. 5	July. 16	July. 22	July. 28	August. 2	August. 6	August. 18	August. 30	Duty of Water.	Rainfall April 1 to Harvest.	Total Depth Rec'd.	Used to Grow the Crop.	Yield per Acre.
																Bush.
43	0·25											0·00	0·59	0·59		57·5
45	0·25		0·33									0·33	0·59	0·92		148·7
46	0·25		0·33			0·34						0·67	0·59	1·26		218·4
47	0·33		0·33		0·33			0·34				1·00	0·59	1·59		255·6
48	0·27	0·33	0·33		0·34		0·33					1·33	0·59	1·92		303·4
49	0·22		0·33	0·33		0·34		0·33		0·34		1·67	0·59	2·26		366·5
50	0·18		0·33	0·33		0·34			0·33	0·33	0·34	2·00	0·59	2·59		314·1

SUMMARY OF RESULTS AT RONALANE SHOWING THE TOTAL DEPTH OF WATER PRODUCING THE MAXIMUM YIELD IN EACH YEAR

Crop.	1915.		1916.		1917.		1918.		1919.		Average.	
	Yield.	Depth.	Yield.	Depth.	Yield.	Depth.	Yield.	Depth.	Yield.	Depth.	Yield.	Depth.
Alfalfa	4·04	1·94	3·82	3·27	3·13	1·68	2·46	1·33	3·11	2·17	3·31	2·08
Wheat	48	1·55	48	1·82	50	1·86	38	2·32	40	1·80	45	1·87
Oats	108	3·00	79	1·82	106	1·36	101	3·32	77	1·50	94	2·20
Barley	48	1·41	56	1·77	55	1·35	84	2·01	56	1·83	60	1·67
Peas	25	1·78	53	2·90	61	1·35	57	2·86	34	2·50	46	2·28
Sugar beets	10	1·55	11	2·24	17	1·16	....	....	....	....	13	1·65
Potatoes	408	2·03	294	1·82	....	....	471	2·36	366	2·26	385	2·12

DUTY OF WATER, COALDALE, ALBERTA, 1919

The work at Coaldale was carried on in the same manner as previously. A motor-car was furnished for this work during the past season, which enabled the engineer to greatly extend the territory over which duty of water observations were being made and secure several new tracts of land.

The precipitation, April to September, was 7.66 inches, as compared with 4.40 inches for 1918 which was the driest year on record since 1902, with the exception of 1910, which had 0.38 inch less rainfall during the growing season.

The mean temperature, April to September, was 56.70°, as compared with 55.90° for 1918. The evaporation for the same period was 37.9 inches for 1919, as compared with 36.1 inches for 1918. In general the season was very similar to 1918, having a slightly greater temperature, evaporation and precipitation.

The table following gives a summary of all the data in regard to the work carried out. All alfalfa fields received two irrigations. No. 302 is the only field from which a third cutting was taken, which was very light.

Plot No. 305 produced the maximum yield for the first cutting of any plot, 2.89 tons per acre. The total yield of the two cuttings, 5.17 tons per acre, is not only the largest yield per acre for 1919 but is the largest obtained from any of the fields since investigations began in 1913. This yield was produced with a total depth of 1.92 feet. The past season was the most favourable one for alfalfa crops since 1913.

For the thirteen fields in forage crops, for 1919, the average total depth of water received was 2.08 feet, and for the thirteen fields in other crops, 1.45 feet.

TABLE No. 2.—DUTY OF WATER TRACTS, COALDALE, ALBERTA, 1919

Plot No.	Acres.	Irrigation. No.	Began.	Ended.	Duration in Hours.	Average Head C.F.S.	Acre-feet per Acre. Supplied.	Wasted.	Used.	Used per Acre.	Duty.	Rainfall April 1 to Harvest.	Total Water Rec'd.	Total Water Used.	Yield. Per Cutting.	Per Acre Tons.	Crop.	Remarks.
302	30·00	1	May 18	May 27	228	1·08	20·12	3·10	17·02	0·85					1·78			
		2	July 6	July 16	162	1·39	18·52	0·00	18·52	0·93	1·78	0·64	2·42	2·52	2·16			
															0·17	4·11	Alfalfa	Seeded 1909
304	42·00	1	May 28	June 7	242	1·56	31·16	2·31	28·85	0·69					2·00			
		2	July 19	Aug. 7	276	1·46	33·34	0·92	52·42	0·77	1·46	0·46	1·92	1·17	2·05	4·05	"	" 1907
305	22·50	1	June 6	June 12	156	1·87	23·94	6·58	17·36	0·77					2·89			
		2	July 22	July 27	125	2·16	22·30	6·83	15·47	0·69	1·46	0·46	1·92	2·04	2·28	5·17	"	" 1912
306		1	May 27	May 31	94	1·04	8·14	0·54	7·60	0·54					2·01			
	14·00	2	July 18	July 22	88	1·20	8·74	0·11	8·63	0·62	1·16	0·46	1·62	1·06	2·23	4·24	"	" 1914
310	19·70	1	May 16	May 22	106	1·44	12·62	0·00	12·62	0·64					2·51			
		2	July 15	July 18	72	4·44	26·23	2·11	24·12	1·22	1·86	0·46	2·32	2·39	2·41	4·92	"	" 1914
312	50·00	1	May 25	May 31	144	3·73	44·40	7·38	37·02	0·74					2·05			
		2	July 10	July 17	170	3·20	45·05	3·57	41·48	0·83	1·57	0·46	2·03	1·64	2·32	4·37	"	" 1914
313	50·00	1	June 13	June 23	256	2·34	49·56	5·10	44·46	0·89					2·86			
		2	July 31	Aug. 7	160	2·68	37·72	0·00	37·72	0·76	1·65	0·46	2·11		2·00	4·86	"	" 1914
314	35·09	1	May 27	June 5	222	2·64	48·48	2·16	46·32	1·32					2·20			
		2	July 18	July 25	166	2·98	40·86	0·00	40·86	1·16	2·48	0·46	2·94	3·47	1·79	3·99	"	" 1914
315	50·00	1	May 19	May 28	224	2·47	45·74	0·00	45·74	0·91					2·49			
		2	July 11	July 26	263	2·66	57·86	0·00	57·86	1·15	2·06	0·43	2·49	2·27	1·34	3·83	"	" 1914
324	32·73	1	May 27	June 16	234	2·04	39·48	0·00	39·48	1·20					2·78			
		2	Aug 1	Aug. 7	135	1·97	22·06	4·12	17·94	0·54	1·74	0·46	2·20	2·94	2·04	4·82	"	" 1914
329	11·00	1	June 6	June 10	101	1·71	14·28	4·17	10·11	0·92					1·49			
		2	July 25	July 29	106	0·74	6·46	1·12	5·34	0·48	1·40	0·46	1·86	2·49	1·00	2·49	"	" 1914
334	16·40	1	May 28	June 3	136	0·76	8·62	0·00	8·62	0·52					1·55			
		2	July 14	Aug. 12	218	0·67	12·07	0·00	12·07	0·73	1·25	0·46	1·71		1·16	2·71	"	
303	22·50	1	May 21	May 27	136	1·39	15·64	0·00	15·64	0·69								
		2	June 16	June 19	76	2·14	12·80	0·00	12·80	0·56	1·25	0·25	1·50	1·98	0·42	0·42	Timothy	" 1914
		Average for forage crops									1·62	0·46	2·08					

TABLE No. 2.—DUTY OF WATER TRACTS, COALDALE, ALBERTA, 1919.

Plot No.	Acres.	Irrigation. No. of Irr.	Began.	Ended.	Duration in Hours.	Average Head in C.F.S.	Acre-feet per Acre. Supplied.	Wasted.	Used.	Used per Acre.	Duty.	Rainfall April 1 to Harvest.	Total Water Rec'd.	Yield. Total Water Used.*	Bushels per Acre.	Crop.	Remarks.
308....	36·00	1	June 17....	June 27...	245	3·13	63·38	7·68	55·70	0·77	0·77	0·43	1·20	0·71	19·4	Wheat......	Foul with wild oats.
316....	62·10	1	June 15....	July 9....	320	3·59	95·01	13·28	81·73	1·31	....	....	....	....	....	....	5 pounds alfalfa per acre seeded
		2	July 18....	July 26...	168	2·40	33·34	0·00	33·34	0·54	1·85	0·46	2·31	1·68	21·0	"	
323....	8·65	1	May 27....	May 29....	53	2·69	11·82	2·10	9·72	1·12	1·12	0·46	1·58	1·65	23·0	"	
325.....	30·50	1	June 12....	June 26....	207	0·94	16·14	0·00	16·14	0·53	....	....	....	....	....	"	
		2	July 5....	July 14...	224	1·00	18·49	0·00	18·49	0·60	1·13	0·43	1·56	1·83	24·8		
328............	6·20	1	June 25....	June 30....	125	0·31	5·32	0·00	5·32	0·86	0·86	0·43	1·29	1·02	34·7	"	
330....	39·90	1	June 20....	June 26....	148	2·68	32·85	0·00	32·85	0·82	0·82	0·43	1·25	1·29	14·5	"	
331....	3·20	1	June 17....	June 20....	62	0·61	3·16	0·00	3·16	0·99	....	....	....	....	....	"	
		2	July 21....	July 23...	49	0·60	2·46	0·00	2·46	0·77	1·76	0·46	2·22	....	17·1	"	Damaged by hail.
332............	4·40	1	June 15....	June 17....	48	1·20	4·78	1·21	3·57	0·81	....	....	....	....	....		
		2	July 2....	July 2...	9	1·71	1·25	0·00	1·25	0·30	1·11	0·46	1·57	1·63	17·0	"	Damaged by hail.
307............	23·50	1	June 28....	July 8...	264	1·38	30·25	3·14	27·11	1·15	1·15	0·46	1·61	....	20·0	Oats........	Part green feed.
316A............	27·20	1	June 15....	July 9....	142	3·59	42·01	9·61	32·40	1·19	1·19	0·46	1·65	....	30·5	"	
326............	6·86	1	June 18....	June 25....	166	0·37	7·68	0·00	7·68	1·12	1·12	0·46	1·58	1·55	43·8	"	
322........	13·30	1	July 16....	July 21....	128	0·27	2·88	0·00	2·88	0·22	0·22	0·65	0·87	0·76	6·5 tons.	Potatoes....	Crop frozen before digging. Estimated loss seventy per cent.
333............	9·70	1	July 2....	July 4....	44	1·00	3·66	0·51	3·15	0·32	....	....	....	....	....	" ..	
		2	Aug. 21....	Aug. 23....	36	0·47	1·41	0·00	1·41	0·14	0·46	0·65	1·11	....	7·0 tons.		
Average for grain and root crops...											1·04	0·48	1·52				
Average for all crops for 1919....											1·33	0·47	1·80				

TABLE SHOWING TOTAL DEPTH OF WATER USED COALDALE TRACTS, 1913 TO 1919.

Crop.	1913.			1914.			1915.			1916.			1917.			1918.			1919.			Average 1913 to 1919 inclusive.		
	Duty.	Precipitation.	Total Water Received.	Duty.	Precipitation.	Total Water Received.	Duty.	Precipitation.	Total Water Received.	Duty.	Precipitation.	Total Water Received.	Duty.	Precipitation.	Total Water Received.	Duty.	Precipitation.	Total Water Received.	Duty.	Precipitation.	Total Water Received.	Duty.	Precipitation.	Total Water Received.
Alfalfa	1·70	0·98	2·68	2·11	0·57	2·68	0·68	1·32	2·00	0·41	1·56	1·97	1·31	0·68	1·99	2·00	0·31	2·31	1·66	0·47	2·13	1·41	0·84	2·25
Timothy	0·85	0·98	1·83	......	......	......	1·28	1·32	2·60	0·33	1·56	1·89	1·48	0·71	2·19	1·30	0·30	1·60	1·25	0·25	1·50	1·08	0·85	1·93
Wheat	0·74	0·98	1·72	......	......	......	0·22	1·32	1·54	0·00	1·73	1·73	0·78	0·41	1·19	1·16	0·29	1·45	1·18	0·44	1·62	0·68	0·86	1·54
Oats	......	......	......	1·49	0·57	2·06	0·00	1·32	1·32	0·00	1·73	1·73	......	......	......	1·04	0·28	1·32	1·15	0·46	1·61	0·74	0·87	1·61
Barley	......	......	......	1·25	0·57	1·82	0·00	1·32	1·32	0·00	1·56	1·56	......	......	......	......	......	......	......	......	......	0·42	1·15	1·57
Average	1·15	0·98	2·13	1·84	0·57	2·41	0·57	1·32	1·89	0·28	1·56	1·84	1·18	0·65	1·83	1·70	0·30	2·00	1·33	0·47	1·80	1·15	0·84	1·99

The above table shows the average total depth of water received (irrigation plus precipitation) for the Coaldale plots from 1913 to 1919. The average total depth of water received for the grain plots is 1.57 feet. The average duty of water for the same seven years is 0.71 foot. For the alfalfa and grasses the average total depth received for seven years is 2.09 feet and the average duty of water is 1.24 feet. For all plots, alfalfa, grasses and grains, the average total depth received for seven years is 1.99 feet. The average duty of water for seven years is 1.15 feet.

BROOKS EXPERIMENT STATION, 1919

During the fall of 1918, all plots which were to be seeded down to crops this spring were ploughed and left over winter with no other cultural preparation. As soon as the land was dry enough this spring, the land was double disced, harrowed and floated.

Soil samples were taken upon each plot at the time of seeding and again at the time of harvest.

The first part of April was rather cold and wet, the frost leaving the ground very slowly, so that it was not until after the twentieth of the month that seeding operations could be commenced. Frost occurred on eighteen nights during April, the last frost occurring on April 30. Precipitation, 1.41 inches.

Frost occurred every night except the second, from May 1 to 8, after which date, except for 5° frost on May 14, no frost was recorded during the remainder of the month; 1·02 inches precipitation for the month, 0·75 inch of which fell during one storm on the 28th. June and July were very similar to the same months in 1918, having very little rain (0.40 inch in June, 1.46 inches in July) and moderately high mean temperatures. The only worth while rain during these two months occurred on July 26, when 0·95 inch of rain fell.

August had 2.40 inches rain and a mean temperature of 64.5 as compared with 64.2 for 1918.

September was somewhat warmer than for 1918 and had a precipitation of 1.77 inches.

Taken as a whole, the season was rather dry, especially so during June and July when the crops needed the greatest quantities of water. For April to September a total precipitation of 8.46 inches was recorded as compared with 3.81 inches for 1918 and 6.81 inches for 1917.

The results of the past season's work is given in the following tables.

In studying the tables it is to be noted that the column *Total Depth Received* is the sum of *duty of water* and *precipitation.*. The column *Total Depth Used in Growing the Crop* shows the depth of water actually used in growing the crop, as determined by soil moisture tests.

Wheat.—In rotation "E" the maximum yield of 51·2 bushels per acre was produced with total depth of 2.16 feet. In rotation "D" the maximum yield of 45.8 bushels per acre was produced with a total depth of 1.76 feet. In rotation "C" the maximum yield of 48.3 bushels per acre was produced with a total depth of 1.93 feet. In rotation "B" the maximum yield of 53.0 bushels per acre was produced with a total depth of 2.10 feet. In rotation "A" the maximum yield of 47.5 bushels per acre was produced with a total depth of 2.43 feet.

Summarizing the results from the five wheat series it is shown that the maximum yields were produced with an average total depth of 2.08 feet, of which 0.44 foot was received as rainfall.

In series B, C, D and E, additional irrigations produced decreases in yield. In series A, the maximum yield is coincident with the maximum depth received. The dry plots yielded from 4.1 to 6.8 bushels per acre. The maximum yield of the five series, 53 bushels per acre, with total depth 2.10 feet was from land which grew root crops in 1918.

Oats.—In rotation " E " the maximum yield of 77·0 bushels per acre was produced with total depth of 1·43 feet. In rotation " D" the maximum yield of 69·0 bushels per acre was produced with a total depth of 1·43 feet. In rotation " C " the maximum yield of 64.0 bushels per acre was produced with total depth of 2.10 feet. In rotation "B" the maximum yield 80.6 bushels per acre was produced with total depth of 1.43 feet.

Summarizing results from four oat series it is shown that the maximum yields were produced with an average total depth of 1.60 feet of which 0.43 foot was received as rainfall. The dry plots yielded from 1.5 to 12.0 bushels per acre.

Flax.—The minimum yield of flax, 25·7 bushels per acre, was produced with a total depth of 1·89 feet. Additional water supplied decreased the yield. The dry plot produced 10·4 bushels per acre.

Barley.—In rotation "E" the maximum yield of 39.2 bushels per acre was produced with a total depth of 2.10 feet. In rotation "C" the maximum yield of 36.7 bushels per acre was produced with a total depth of 2.10 feet. In rotation "B" the maximum yield, 35.5 bushels per acre, was produced with a total depth of 1.43 feet.

The maximum yields in the barley series were obtained with an average depth of 1.88 feet, of which 0.43 foot was rainfall. In all barley series additional irrigations beyond the optimum depth decreased the yield. The dry plots yielded from 9·6 to 11·1 bushels per acre.

Alfalfa Seed Production.—The best yield of alfalfa seed, 12·5 bushels per acre, was produced with a total depth of 1.30 feet from that portion of plot 41D which was seeded in hills three feet apart. An additional irrigation decreased the yield. The dry plot produced 4·8 bushels per acre.

Where the alfalfa was sown in rows the maximum yield, 9·7 bushels per acre, was produced with a total depth of 1.55 feet and where seeded in drills the maximum yield, 11·5 bushels per acre, was produced with a total depth of 1·55 feet. Where sown in rows and drills the maximum yield is produced with the maximum depth received.

The alfalfa sown in hills has shown the best results this year, not only giving the maximum yield per acre but giving it at a less water cost than the other two methods of seeding. The first four irrigations especially show much larger yields for the depth received than are obtained from the row and drill divisions.

Peas.—The maximum yield of peas, 56.8 bushels per acre, was produced with a total depth of 2.56 feet. The dry plot produced 4.0 bushels per acre. The maximum yield was produced with the maximum depth, indicating a higher duty for peas than for any other grains.

Potatoes.—In rotation "C" the maximum yield of potatoes, 360 bushels per acre, was produced with a total depth of 1.71 feet, the dry plot producing 192 bushels per acre. This crop followed a crop of oats. In rotation "A" the maximum yield, 406 bushels per acre, was produced with a total depth of 1.54 feet, the dry plot producing 258 bushels per acre. This crop followed peas. An added irrigation decreased the yield.

Summarizing the results of the two potato series it is shown that the maximum yields were produced with an average total depth of 1.62 feet of which 0.71 was received as rainfall.

WHEAT (MARQUIS) 1919.

Rotation E.

Plot No.	Area in Acres	Irrigation — Date and Depth Applied in Acre-feet per Acre. May.	June.				July.					Duty of Water.	Rainfall April 15 to Harvest.	Total Depth Received.	Total Depth Used to Grow the Crop.	Yield in Bushels per Acre.
		31	9	15	19	26	8	17	19	22	28					
7B	0·120											0·00	0·34	0·34	1·05	5·0
6	0·242				0·33							0·33	0·36	0·69	0·93	20·8
5	0·242			0·33			0·34					0·67	0·49	1·16	1·04	36·8
4	0·242			0·33		0·33		0·34				1·00	0·49	1·49	1·39	47·5
3	0·222		0·33			0·33		0·34			0·33	1·33	0·49	1·82	1·60	50·3
2	0·242	0·33			0·33		0·34			0·33	0·34	1·67	0·49	2·10	1·83	51·2
1	0·242	0·33		0·33		0·34	0·33			0·33	0·34	2·00	0·49	2·49	1·46	42·3
10	0·242			0·50			0·50					1·00	0·49	1·49	1·50	42·7
9	0·242			0·50		0·50			0·50			1·50	0·49	1·99	1·75	38·7
8	0·242		0·50			0·50			0·50		0·50	2·00	0·49	2·49	2·05	40·7

Rotation D.

		30	7	13	19	27	7	9	16	22	28					
82	0·050											0·00	0·34	0·34	0·51	4·8
81A	0·040				0·33							0·33	0·43	0·76	0·87	21·1
81B	0·031			0·33			0·34					0·67	0·43	1·10	1·09	36·6
81C	0·038			0·33		0·33			0·34			1·00	0·43	1·43	1·39	43·9
81D	0·046		0·33			0·33			0·34		0·33	1·33	0·43	1·76	1·74	45·8
81E	0·042	0·33			0·33		0·34			0·33	0·34	1·67	0·43	2·10	1·71	42·3
81G	0·060	0·33		0·33		0·34		0·33		0·33	0·34	2·00	0·43	2·43	1·92	43·4
81F	0·025			0·50				0·50				1·00	0·43	1·43	1·66	44·0
80A	0·018		0·50			0·50			0·50			1·50	0·43	1·93	1·32	45·8
80B	0·029		0·50			0·50			0·50		0·50	2·00	0·43	2·43	1·36	36·0

Rotation C.

		27	6	11	18	25	5	15	21	28						
91A	0·043											0·00	0·38	0·38	1·02	4·1
91B	0·043				0·33							0·33	0·38	0·71	1·14	17·1
91C	0·045			0·33			0·34					0·67	0·43	1·10	1·40	29·8

91D	0·040			0·33		0·33		0·34				1·00	0·43	1·43	1·65	37·5
91E	0·007		0·33			0·33		0·34		0·33		1·33	0·43	1·76	1·95	41·8
92A	0·050	0·33			0·33		0·34		0·33	0·34		1·67	0·43	2·10	2·20	45·8
92B	0·057	0·33		0·33		0·34	0·33		0·33	0·34		2·00	0·43	2·43	2·19	44·1
92C	0·065			0·50			0·50					1·00	0·43	1·43	1·37	34·9
92D	0·030			0·50		0·50		0·50				1·50	0·43	1·93	2·27	48·3
92E	0·060		0·50			0·50		0·50		0·50		2·00	0·43	2·43	2·43	44·3

Rotation B.

		28	7	12	18	26	5	7	16	21	29					
66A	0·016											0·00	0·26	0·26	0·60	4·8
66B	0·024				0·33							0·33	0·36	0·69	0·86	17·5
66C	0·024			0·33			0·34					0·67	0·36	1·03	1·17	21·4
66D	0·024			0·33		0·33			0·34			1·00	0·43	1·43	1·53	39·7
66E	0·024		0·33			0·33			0·34		0·33	1·33	0·43	1·76	1·92	42·0
67A	0·045	0·33			0·33		0·34			0·33	0·34	1·67	0·43	2·10	2·18	53·0
67B	0·033	0·33		0·33		0·34	0·33			0·33	0·34	2·00	0·43	2·43	2·64	52·7
67C	0·033			0·50				0·50				1·00	0·43	1·43	1·85	42·2
67D	0·033			0·50		0·50			0·50			1·50	0·43	1·93	2·72	46·7
67E	0·033		0·50			0·50			0·50		0·50	2·00	0·43	2·43	2·51	51·2

Rotation A.

		29	6	12	18	25	7	16	21	28						
48A	0·032											0·00	0·34	0·34	0·41	6·8
48B	0·032				0·33							0·33	0·38	0·71	0·79	21·2
48C	0·032			0·33			0·34					0·67	0·43	1·10	1·25	33·2
48D	0·022			0·33		0·33		0·34				1·00	0·43	1·43	1·55	35·9
48E	0·013		0·33			0·33		0·34		0·33		1·33	0·43	1·76	1·56	40·8
49A	0·032	0·33			0·34		0·33		0·33	0·33		1·67	0·43	2·10	1·54	44·1
49B	0·032	0·33		0·33		0·34	0·33		0·33	0·34		2·00	0·43	2·43	1·97	47·5
49C	0·032			0·50			0·50					1·00	0·43	1·43	1·62	44·1
49D	0·032			0·50		0·50		0·50				1·50	0·43	1·93	2·23	44·1
49E	0·032		0·50			0·50		0·50		0·50		2·00	0·43	2·43	2·29	34·9

OATS (BANNER), 1919.

Rotation E.

Plot No.	Area in Acres.	Irrigation. Date and Depth Applied in Acre-feet per Acre. May. 31	June. 10	June. 15	June. 19	June. 26	July. 9	July. 17	July. 22	July. 28	Duty of Water.	Rainfall April 1 to Harvest.	Total Depth Rec'd.	Total Depth Used in Growing the Crop.	Yield in Bushels per Acre.
14B	0·121										0·00	0·26	0·26	0·59	2·9
15	0·242				0·33						0·33	0·26	0·59	0·84	30·2
16	0·237			0·33			0·34				0·67	0·38	1·05	1·10	56·0
17	0·240			0·33		0·33		0·34			1·00	0·43	1·43	1·33	72·1
18	0·242		0·33			0·33		0·34		0·33	1·33	0·43	1·76	1·64	71·8
19	0·242	0·33			0·33		0·34		0·33	0·34	1·67	0·43	2·10	1·85	71·8
20	0·242	0·33		0·33		0·34	0·33		0·33	0·34	2·00	0·43	2·43	1·76	66·8
11	0·242			0·50			0·50				1·00	0·43	1·43	1·36	77·0
12	0·243			0·50		0·50		0·50			1·50	0·43	1·93	1·72	65·6
13	0·242		0·50			0·50		0·50		0·50	2·00	0·43	2·43	1·89	69·3

Rotation D.

Plot No.	Area in Acres.	May. 30	June. 7	June. 12	June. 19	June. 26	July. 7	July. 17	July. 21	July. 30	Duty of Water.	Rainfall April 1 to Harvest.	Total Depth Rec'd.	Total Depth Used in Growing the Crop.	Yield in Bushels per Acre.
78A	0·033										0·00	0·38	0·38	0·80	1·5
78B	0·033				0·33						0·33	0·38	0·71	0·87	41·7
78C	0·031			0·33			0·34				0·67	0·38	1·05	1·07	56·9
78D	0·047			0·33		0·33		0·34			1·00	0·43	1·43	1·31	69·0
78E	0·031		0·33			0·33		0·34		0·33	1·33	0·43	1·76	1·50	69·0
79A	0·032	0·33			0·33		0·34		0·33	0·34	1·67	0·43	2·10	1·70	68·9
79B	0·032	0·33		0·33		0·34	0·33		0·33	0·34	2·00	0·43	2·43	1·90	52·3
79C	0·032			0·50			0·50				1·00	0·43	1·43	1·46	57·8
79D	0·032			0·50		0·50		0·50			1·50	0·43	1·93	1·78	52·3
79E	0·030		0·50			0·50		0·50		0·50	2·00	0·43	2·43	2·11	55·8

Rotation B.

Plot No.	Area in Acres.	May. 30	June. 6	June. 12	June. 19	June. 26	July. 7	July. 16	July. 21	July. 29	Duty of Water.	Rainfall April 1 to Harvest.	Total Depth Rec'd.	Total Depth Used in Growing the Crop.	Yield in Bushels per Acre.
64A	0·033										0·00	0·43	0·43	1·12	2·0
64B	0·033				0·33						0·33	0·43	0·76	0·98	69·5
64C	0·034			0·33			0·34				0·67	0·43	1·10	1·58	71·8
64D	0·034			0·33		0·33		0·34			1·00	0·43	1·43	1·75	80·6
64E	0·034		0·33			0·33		0·34		0·33	1·33	0·43	1·76	1·91	79·0

65A	0·036	0·33			0·33		0·34		0·33	0·34	1·67	0·43	2·10	1·70	73·5
65B	0·036	0·33		0·33		0·33	0·34		0·34	0·33	2·00	0·43	2·43	1·66	62·1
65C	0·036			0·50			0·50				1·00	0·43	1·43	1·34	47·4
65D	0·036			0·50		0·50		0·50			1·50	0·43	1·93	1·55	56·2
65E	0·032		0·50			0·50		0·50		0·50	2·00	0·43	2·43	1·84	51·2

Rotation C.

		27	6	11	18	25	5	15	21	28					
89A	0·033										0·00	0·38	0·38	0·58	12·6
89B	0·034				0·33						0·33	0·38	0·71	0·84	35·0
89C	0·034			0·33			0·34				0·67	0·38	1·05	1·33	41·1
89D	0·034			0·33		0·33		0·34			1·00	0·43	1·43	1·54	46·7
89E	0·035		0·33			0·33		0·34		0·33	1·33	0·43	1·76	1·80	49·8
90A	0·036	0·33			0·33		0·34		0·33	0·34	1·67	0·43	2·10	1·90	64·0
90B	0·036	0·33		0·33		0·34	0·33		0·33	0·34	2·00	0·43	2·43	2·01	55·0
90C	0·036			0·50			0·50				1·00	0·43	1·43	1·56	50·2
90D	0·035			0·50		0·50		0·50			1·50	0·43	1·93	1·62	49·7
90E	0·035		0·50			0·50		0·50		0·50	2·00	0·43	2·43	2·05	64·0

FLAX (NORTH DAKOTA RESISTANT No. 73), 1919.

Rotation A.

Plot No.	Area in Acres.	Irrigation. Date and Depth Applied in Acre-feet per Acre.										Duty of Water.	Rainfall April 1 to Harvest.	Total Depth Rec'd.	Total Depth Used to Grow the Crop.	Yield in Bushels per Acre.
		May			June			July								
		30	7	13	20	25	28	8	17	22	30					
46A	0·012											0·00	0·56	0·56	0·80	10·4
46B	0·032				0·33							0·33	0·56	0·89	0·95	17·3
46C	0·032			0·33				0·34				0·67	0·56	1·23	1·28	20·6
46D	0·032			0·33			0·33		0·34			1·00	0·56	1·56	1·45	23·4
46E	0·032		0·33				0·33		0·34		0·33	1·33	0·56	1·89	1·61	25·7
47A	0·032	0·33			0·33			0·34		0·33	0·34	1·67	0·56	2·23	1·80	20·6
47B	0·032	0·33		0·33		0·34		0·33		0·33	0·34	2·00	0·56	2·56	2·10	17·3
47C	0·032			0·50				0·50				1·00	0·56	1·56	1·40	16·2
47D	0·032			0·50		0·50			0·50			1·50	0·56	2·06	1·71	20·6
47E	0·032		0·50			0·50			0·50		0·50	2·00	0·56	2·56	2·25	20·6

BARLEY (O. A. C. No. 21), 1919.

Rotation E.

Plot No.	Area in Acres.	Irrigation. Date and Depth Applied in Acre-feet per Acre. May.	June.					July.				Duty of Water.	Rainfall April 1 to Harvest.	Total Depth Rec'd.	Total Depth Used in Growing the Crop.	Yield in Bushels per Acre.
		30	9	15	17	20	27	8	18	21	28					
30A												0·00				
26	0·242					0·33						0·33	0·26	0·59	0·85	17·0
25	0·242			0·33				0·34				0·67	0·38	1·05	1·07	29·7
24	0·242			0·33			0·33		0·34			1·00	0·43	1·43	1·30	37·0
23	0·242		0·33				0·33		0·34		0·33	1·33	0·43	1·76	1·36	37·4
22	0·242	0·33				0·33		0·34		0·33	0·34	1·67	0·43	2·10	1·45	39·2
21	0·242	0·33					0·34	0·33		0·33	0·34	2·00	0·43	2·43	1·58	33·8
30	0·163				0·50			0·50				1·00	0·43	1·43	1·39	34·6
29	0·196				0·50		0·50		0·50			1·50	0·43	1·93	1·55	32·1
28	0·223		0·50				0·50		0·50		0·50	2·00	0·43	2·43	1·85	38·4
Rotation C.																
		26	7	10	18	25	5	15	21	29						
87A	0·013											0·00	0·37	0·37	0·34	9·6
87B	0·034				0·33							0·33	0·37	0·70	0·97	25·1
87C	0·034			0·33			0·34					0·67	0·43	1·10	1·05	26·4
87D	0·034			0·33		0·33		0·34				1·00	0·43	1·43	1·46	29·4
87E	0·034		0·33			0·33		0·34		0·33		1·33	0·43	1·76	1·47	29·4
88A	0·025	0·33			0·33		0·34		0·33	0·34		1·67	0·43	2·10	1·42	36·7
88B	0·034	0·33		0·33		0·34	0·33		0·33	0·34		2·00	0·43	2·43	1·65	29·4
88C	0·035			0·50			0·50					1·00	0·43	1·43	1·28	24·4
88D	0·033			0·50		0·50		0·50				1·50	0·43	1·93	1·67	32·8
88E	0·034		0·50			0·50		0·50		0·50		2·00	0·43	2·43	1·85	36·7
Rotation B.																
		28	6	12	19	26	7	16	21	29						
62A	0·015											0·00	0·37	0·37	0·64	11·1
62B	0·034				0·33							0·33	0·37	0·70	0·77	20·2
62C	0·034			0·33			0·34					0·67	0·37	1·04	0·94	30·0

62D	0·034			0·33		0·33		0·34				1·00	0·43	1·43	1·29	35·5
62E	0·034		0·33			0·33		0·34		0·33		1·33	0·43	1·76	1·43	24·5
63A	0·034	0·33			0·33		0·34		0·33	0·34		1·67	0·43	2·10	1·40	34·3
63B	0·034	0·33		0·33		0·34	0·33		0·33	0·34		2·00	0·43	2·43	1·52	32·5
63C	0·034			0·50			0·50					1·00	0·43	1·43	1·37	30·0
63D	0·034			0·50		0·50		0·50				1·50	0·43	1·93	1·70	35·5
63E	0·034		0·50			0·50		0·50		0·50		2·00	0·43	2·43	1·66	33·1

ALFALFA SEED (A. B. LYMAN'S GRIMM), 1919.

Plot No.	Area in Acres.	Irrigation. Date and Depth Applied in Acre-feet per Acre. May.	June. 7	June. 14	June. 19	June. 28	July. 8	July. 15	July. 30	Duty of Water.	Rainfall April 1 to Harvest.	Total Depth Rec'd.	Total Depth Used in Growing the Crop.	Yield per Acre. Bush. Sown in Hills.	Sown in Rows.	Sown in Drills.
41A	0·037									0·00	0·55	0·55	0·67	4·8	0·7	2·5
41B	0·037				0·25					0·25	0·55	0·80	0·92	9·2	2·1	3·9
41C	0·037			0·25			0·25			0·50	0·55	1·05	1·14	11·8	3·5	7·7
41D	0·037			0·25		0·25		0·25		0·75	0·55	1·30	1·36	12·5	7·0	8·3
41E	0·037		0·25			0·25		0·25	0·25	1·00	0·55	1·55	1·46	11·8	9·7	11·5

PEAS (PRUSSIAN BLUE), 1919.

Rotation E.

Plot No.	Area in Acres.	Irrigation. Date and Depth Applied in Acre-feet per Acre. May. 30	June. 10	June. 15	June. 20	June. 26	July. 9	July. 18	July. 22	July. 28	Duty of Water.	Rainfall April 1 to Harvest.	Total Depth Rec'd.	Total Depth Used to Grow the Crop.	Yield in Bushels per Acre.
32	0·032										0·00	0·26	0·26	0·53	4·0
31	0·084				0·33						0·33	0·43	0·76	0·76	15·8
36	0·228			0·33			0·34				0·67	0·49	1·16	1·12	21·5
37	0·231			0·33		0·33		0·34			1·00	0·52	1·52	1·46	32·2
38	0·235		0·33			0·33		0·34		0·33	1·33	0·52	1·85	1·81	38·4
39	0·235	0·33			0·33		0·34		0·33	0·34	1·67	0·56	2·23	2·23	46·5
40	0·239	0·33		0·33		0·34	0·33		0·33	0·34	2·00	0·56	2·56	2·41	56·2
33	0·068			0·50			0·50				1·00	0·43	1·43	1·15	25·7
34	0·078			0·50		0·50		0·50			1·50	0·56	2·06	1·48	53·5
35	0·077		0·50			0·50		0·50		0·50	2·00	0·56	2·56	2·35	56·8

POTATOES (GOLD COIN), 1919

Rotation C.

Plot No.	Area in Acres.	Irrigation. Date and Depth Applied in Acre-feet per Acre. June.			July.				Aug.	Sept.	Duty of Water.	Rainfall April 1 to Harvest.	Total Depth Rec'd.	Total Depth Used in Growing the Crop.	Yield in Bushels per Acre.
		1	21	25	4	14	25	29	18	3					
93A	0·019										0·00	0·71	0·71		192
93B	0·036				0·16						0·16	0·71	0·87		208
93C	0·049			0·16			0·17				0·33	0·71	1·04		205
93D	0·055			0·16		0·17		0·17			0·50	0·71	1·21		224
93E	0·057		0·16			0·17		0·17	0·17		0·67	0·71	1·38		283
94A	0·074	0·16		0·16		0·17		0·17	0·17		0·83	0·71	1·54		289
94B	0·071	0·16		0·16		0·17		0·17	0·17	0·17	1·00	0·71	1·71		306
94C	0·067			0·25			0·25				0·50	0·71	1·21		220
94D	0·031			0·25			0·25		0·25		0·75	0·71	1·46		309
94E	0·031		0·25			0·25		0·25	0·25		1·00	0·71	1·71		360

Rotation A.

Plot No.	Area in Acres.	June.			July.				Aug.	Sept.	Duty of Water.	Rainfall April 1 to Harvest.	Total Depth Rec'd.	Total Depth Used in Growing the Crop.	Yield in Bushels per Acre.
		2	21	25	4	14	25	29	18	3					
50A	0·0[illegible]0										0·00	0·71	0·71		258
50B	0·041				0·16						0·16	0·71	0·87		268
50C	0·041			0·16			0·17				0·33	0·71	1·04		284
50D	0·041			0·16		0·17		0·17			0·50	0·71	1·21		297
50E	0·041		0·16			0·17		0·17	0·17		0·67	0·71	1·38		345
51A	0·041	0·16		0·16		0·17		0·17	0·17		0·83	0·71	1·54		406
51B	0·041	0·16		0·16		0·17		0·17	0·17	0·17	1·00	0·71	1·71		347
51C	0·041			0·25			0·25				0·50	0·71	1·21		3[illegible]9
51D	0·041			0·25			0·25		0·25		0·75	0·71	1·46		349
51E	0·041		0·25			0·25		0·25	0·25		1·00	0·71	1·71		381

DISCUSSION OF SUMMARIZED DATA

The natural precipitation varies greatly from year to year and directly affects the duty of water. In dry years a greater depth of irrigation is required than in wet years. The clearest way to view the matter is to consider both natural precipitation and irrigation water simply as so much depth of water applied to the crops. Then by adding together natural precipitation and irrigation we get the total depth of water applied and thus have figures which are readily comparable from year to year. This latter statement must not be accepted absolutely, because the seasonable distribution of the precipitation and temperature also has a marked effect on the crop growth. It must always be kept in mind that soil and subsoil conditions have a very marked effect on the duty of water, so that in comparing results gained at different places many conditions must be considered to get a true perspective.

The first table below is inserted to show the climatic conditions for the six years 1914 to 1919, at the four stations from which data have been taken in writing the general discussion on duty of water for the several crops which follows.

The second table is inserted for purposes of comparison showing the average climatic conditions which prevailed during the five years as compared with long term averages. In both cases the period April to September, both inclusive, is used.

—	Precipitation.						Temperature.					
	1914.	1915.	1916.	1917.	1918.	1919.	1914.	1915.	1916.	1917.	1918.	1919.
	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.	°F.	°F.	°F.	°F.	°F.	°F.
Strathmore	0·71	1·44	1·33	0·85	0·48	1·09	52·4	52·6	50·6	52·0	52·8	52·9
Ronalane	0·38	0·93	1·32	0·50	0·38	0·57	59·4	57·1	55·2	55·8	56·8	58·4
Coaldale	0·57	1·32	1·56	0·72	0·37	0·64	55·9	55·4	54·5	55·4	55·9	56·7
Brooks	......	......	......	0·57	0·32	0·70	55·6	56·3	......	56·3	58·0	57·5

—	Precipitation.		Temperature.	
	1914-1919.	Long Term.	1914-1919.	Long Term.
	Feet.	Feet.	°F.	°F.
Calgary	0·77	1·02	54·79	52·52
Medicine Hat	0·75	0·78	59·33	59·06
Lethbridge	0·86	0·97	55·08	55·80

Calgary—Index for Strathmore—long term records 1885-1919; Medicine Hat—Index for Ronalane and Brooks—long term records 1884-1919; Lethbridge—Index for Coaldale—long term records 1903-1919.

The following chart is included to indicate the different soil conditions at Strathmore, Ronalane, Coaldale and Brooks.

DIAGRAM SHOWING TYPICAL SOILS OF—

—	Strathmore.	Ronalane.	Coaldale.	Brooks.
	Sandy Soil.	Fine Sandy Loam Soil.	Clay Loam.	Fine Sandy Loam.
First Foot	Fine Sandy Soil to depth varying from 3 to 7 feet.		Light Clay Loam very uniform has no impervious stratum.	Very uniform soil. Very fine sand and silt. Light gravel at 12 to 14 feet depth.
Second Foot		Sandy Loam.		
Third Foot				
Fourth Foot				
Fifth Foot	Heavy clay and gumbo subsoil. Very impervious.	Sand and Gravel.		
Sixth Foot				

In previous reports attention has been drawn to the difficulty of drawing definite conclusions from the data available. In work of this nature where results vary from year to year, it is necessary to have them tabulated consecutively over a considerable period of years before definite conclusions can be drawn. Instead of waiting until the end of the period before publishing results, it has been thought better to publish the data and also such conclusions as could be drawn from it annually. Previously it has been the endeavour to summarize the results gained, under a short written statement regarding each crop. As the period of years to which reference has to be made lengthens, this method becomes more and more difficult and apt to be confusing. In this report the data have all been summarized in the table below, which it is thought shows correctly the average of all results gained to date. The column *Yield* is inserted as a useful index to the results gained at the different places. The column *Depth* shows the total of water received in feet (irrigation plus precipitation). The *average depth* shown is the average of the depths at the different places weighted according to the number of years records. The column marked *Average Depth* shows the average for Coaldale, Ronalane, and Brooks. The data at Coaldale are based on results gained by average farmers irrigating their own fields over a period of seven years. The yields at Coaldale have been omitted because they would not be comparable with the yields obtained on the small plots. The results at Ronalane are based on plot work carried on consistently for five years and constitute the most reliable data available at the present time. The results at Brooks are based on plot work but cover the years 1918 and 1919 only. For Ronalane and Brooks the figures shown are the average at each place, of the total depths of water producing the best crop in each year; for Coaldale the figures represent the average for ordinary crops in each year.

Crop.	Coaldale.		Ronalane.		Brooks.		Average Depth.
	Yield.	Depth.	Yield.	Depth.	Yield.	Depth.	
			Bush.		Bush.		
Wheat	....	1·54	44·7	1·87	47·1	2·04	1·73
Oats	....	1·61	91·4	2·04	88·3	1·75	1·78
Barley	....	1·57	60·0	1·67	55·5	1·86	1·65
Peas	....	....	45·9	2·28	52·4	2·32	2·29
Potatoes	....	0·83	384·9	2·12	347·0	1·95	1·89
Flax	....	....	....	....	27·9	2·06	2·06
Alfalfa Seed	....	....	....	....	12·5	1·30	1·30
			Tons		Tons		
Alfalfa	....	2·25	3·31	2·07	....	....	2·18
Grasses	....	1·95	....	....	....	....	1·95
Sugar Beets	....	....	14·00	1·65	....	....	1·65

The average depth noted in the table above indicates quite closely the total depths required for the various crops in that part of Alberta south of township twenty-eight, and exclusive of the strip of country influenced by proximity to the foot-hills and latitude which might be generally described as the territory lying west of range twenty-three.

If we assume that ultimately all irrigated farms will be one-half sown down to alfalfa and one-half cropped to one of the common grains, we are assuming a condition that represents a high water requirement and a sound system of crop rotation. The average depth for wheat, oats, and barley is 1·72 feet. For alfalfa the depth is 2·18 feet. Under the condition assumed then, the total depth required for the whole area would be the mean of these two figures or 1·95 feet. Under this condition, with the legal duty of 1·50 feet we must rely upon a precipitation of 0·45 foot (about 5¼ inches) to meet the crop requirements. The past season was nearly as dry as 1918 (which for the period April to September inclusive, for Coaldale, Ronalane and Brooks had an average precipitation of 0·36 foot, or 4¼ inches, being as dry a season as ever has

been experienced in Alberta) having for the period April to September, for the three above stations an average precipitation of 7·65 inches or 0·64 foot. The average long term precipitation for this season at Medicine Hat and Lethbridge is 0·875 foot or 10·5 inches.

GENERAL CROP REPORT

It has been customary to submit a report each year giving some description of the crops produced under irrigation in the several districts. During 1919 there was a very short water supply in many of the smaller streams from which the private irrigation ditches divert their water, consequently in many districts there was not much irrigation carried out. At the same time the inspecting engineers, who usually obtain these crop reports, were so overloaded with urgent inspectional work that they were not able to gain information concerning crop reports while they were in the field. A good deal of information concerning the crops grown, particularly in a part of the Cypress Hills district, has been gained through correspondence with the irrigators, and this information has all been properly tabulated in the office at Calgary. The data regarding crops grown are much less complete this year than usual. As other work was pressing in the office no attempt has been made to write a report on this subject or publish such definite data as have been tabulated.

EVAPORATION FROM A FREE WATER SURFACE

The data hereunder have been gained by using galvanized iron tanks four feet in diameter and eighteen inches deep, set in the ground with the top from one to two inches above the ground. Daily measurements were made of the quantity of water added or taken out to keep the water surface at a fixed point within the tank at approximately the same elevation as the surrounding ground.

COALDALE, ALTA.

Month.	Total Evaporation in Inches.					Average 5 Years.
	1915.	1916.	1917.	1918.	1919.	
April	5·68	1·51	2·55	3·20	6·59	3·91
May	4·28	5·12	4·83	6·76	5·20	5·24
June	2·26	4·68	5·78	7·88	7·30	5·58
July	4·38	6·20	9·20	7·68	8·12	7·11
August	4·97	4·70	5·23	6·79	6·91	5·72
September	2·93	3·59	4·35	3·76	3·81	3·69
Total	24·50	25·80	31·94	36·07	37·93	31·25

STRATHMORE, ALTA.

Month.	Total Evaporation in Inches.					Average 5 Years.
	1915.	1916.	1917.	1918.	1919.	
April	4·22	2·59	2·09	2·88	4·15	3·19
May	4·73	3·46	3·70	4·58	6·42	4·58
June	4·33	4·59	4·60	5·83	6·42	5·15
July	6·47	4·84	5·88	6·13	5·46	5·76
August	4·25	3·16	3·66	4·01	3·65	3·74
September	2·27	2·66	2·27	2·62	1·64	2·29
Total	26·27	21.30	22·20	26·05	27·74	24·71

BROOKS, ALTA.

Month.	Total Evaporation in Inches.					Average 5 Years.
	1915.	1916.	1917.	1918.	1919.	
April	....	....	....	5·68	2·47	4·07
May	....	....	....	8·47	6·07	7·27
June	....	....	....	8·50	7·33	7·92
July	....	....	....	9·57	7·15	8·36
August	....	....	....	6·80	5·21	6·01
September	....	....	....	3·84	3·21	3·52
Total	....	....	....	42·86	31·44	37·15

REPORT ON DRAINAGE SURVEYS AND INSPECTIONS

By R. J. Burley, B.Sc., M.E.I.C., *Assistant Director and Chief Engineer of the Drainage Division*

In his annual report for last year the director traced briefly the negotiations carried on by the Dominion Government and the provinces of Alberta, Saskatchewan, and Manitoba relating to an arrangement whereby apparently conflicting interests could be brought into harmony and a progressive policy regarding the important question of drainage formulated by each of the parties to the agreement. The agreement reached was made effective by the enactment of "The Reclamation Act," Chapter 5, of the Statutes of Canada, 1919, the "Reclamation Act of Alberta," and the "Reclamation Act, 1917," of the province of Saskatchewan, together with the Drainage Regulations of the Dominion Government, sanctioned by Order in Council dated January 14, 1919. Provision is made in the Dominion Reclamation Act for its application to Dominion Lands in the province of Manitoba when the necessary legislation is enacted by that province.

The formation of the Drainage Division of this Service was approved by the minister in February, 1919, and work was at once commenced to build up an organization capable of handling drainage surveys, inspections, and construction as efficiently and economically as possible. Owing to the amount of necessary preliminary work, both in engaging experienced engineers, draughtsmen, and clerks, and making an office investigation into the projects which had been brought to the attention of the department, a somewhat late start was made on actual field-work and the parties were not able to commence operations until about June 1. Winter conditions set in throughout the northern portions of Alberta, Saskatchewan, and Manitoba early in October, slowing up many of the survey operations; on the other hand, some of the work, such as sounding and carrying lines over muskegs, was facilitated by winter conditions, so that while living conditions were rendered rather unpleasant the parties were able to carry on field-work until December. In one case work was commenced in the middle of November and continued throughout the winter. On the whole the survey season of 1919, being the third dry season in succession, was particularly favourable for drainage surveys, and, as a consequence, very good progress was made in the investigation of the projects which had been brought before the department from time to time by petition, application to purchase, or otherwise.

ORGANIZATION

In planning the scheme of organization, it was decided to place a supervising engineer in general charge of all field operations. Each province was then organized and placed under the supervision of a senior engineer to whom all of the assistant engineers in that province should directly report.

Mr. J. S. Tempest, who was given general charge of all field-work, also made most of the inspections of private schemes undertaken last season. Mr. W. F. Graham was given charge of the work in Alberta, Mr. G. F. Horsey in Saskatchewan, and Mr. W. C. Warren in Manitoba. Operating under the direction of these engineers, there were in each of the provinces of Alberta and Saskatchewan one large location party and one reconnaissance party. In addition, one reconnaissance party carried on special work at various points throughout the three provinces.

The general idea underlying this organization was that reconnaissance surveys should be carried on by small inexpensive parties to enable the department to judge, at the lowest cost possible, as to whether or not projects which had been brought to its attention were worthy of more complete investigation. This being the first season's work, some difficulty was experienced in carrying out the programme planned, since the location party in Alberta had to start on projects of which reconnaissance surveys had not been undertaken, although in this province some preliminary inspections had been made by departmental engineers under the direction of the Commissioner of Irrigation at Calgary.

This general scheme of organization was found to work satisfactorily and is being continued during the present season.

METHODS OF CARRYING ON INVESTIGATION

In investigations of any particular project the original reconnaissance survey merely determines the general feasibility of the scheme. Information as to levels, general slopes, condition of the land regarding quality of soil and subsoil, class of vegetation, and as to whether or not the area is timbered to such an extent as to render the scheme of drainage impracticable, is obtained.

If the reconnaissance survey indicates that the project is a promising one, a location party is placed on the work and complete surveys are made, including the location of contours at one-foot intervals, the location and design of the necessary canals and laterals, the design of structures, and the assessment of cost upon the lands which will be benefited by the project, if constructed.

Soil samples are taken at representative points throughout the area and are first tested in the field by an electrolytic bridge. If these tests indicate the presence of alkali in dangerous amount the samples are sent to Ottawa and chemically analyzed to determine whether or not these salts are sufficient to prove injurious to plant growth. At the same time, the chemical analysis shows the relative percentages of soil constituents valuable to plant growth. A physical analysis is also made, to properly classify the soil as to texture and to determine whether or not it is likely to become suitable for agriculture after drainage.

Projects Investigated

MANITOBA

Three investigations were carried on in the province of Manitoba at the request of the Soldier Settlement Board, and one at the request of the settlers in the district affected.

Dauphin and Ochre Project, near Dauphin

The settlers of this district requested that the Federal Government undertake surveys to determine the cause of the flooding of their lands and the best methods of reclamation. Investigation showed that the overflow upon the lower farm lands was due to the natural run-off from the Riding mountains. The streams flatten out in grade upon reaching the plains and the velocity of flow becomes checked. During flood periods they overflow their banks and flood the adjoining farm lands.

Levels were run throughout the area affected, and alternative schemes were suggested whereby the interested municipalities might overcome the troubles resulting from this natural overflow.

Swan River Project, townships 32, 33 and 34, Ranges 21, 22 and 23, and townships 35, 36 and 37, ranges 22, 23, 24 and 25, W. Pr. Meridian

Of this large area of approximately 700 square miles, all of which is more or less swampy, some 200 square miles were found to have soil of a quality suitable for agriculture. This area could be drained cheaply, but it is very largely wooded, and approximately 75 per cent of the land would require a considerable expenditure for clearing. Under these conditions, further investigations or operations cannot be recommended at the present time.

Mantagao River Project, townships 28 to 31, ranges 3 and 4, W. Pr. Meridian

This project involves a large area, but the major portion of it proved to be land of little value for agricultural purposes after reclamation. Some 19,000 acres were found which would be of value for agriculture after drainage, and which could be drained for about $12.50 per acre. Owing, however, to its distance from railway facilities, and to the growth of timber and moss on the land, it is not recommended for further development at present.

Brokenhead River Project, townships 9 and 10, ranges 8 and 9, E. Pr. Meridian

In September of last year the Great War Veterans Association of Winnipeg called the attention of the Soldier Settlement Board to a large swampy area lying along the valley of the Brokenhead river some 30 to 40 miles from Winnipeg. Major E. J. Ashton, Commissioner of the Board, submitted this correspondence to the Reclamation Service and asked us to undertake an investigation into the drainage possibilities in this district.

A party was placed in the field early in November and worked throughout the winter, submitting a report in April of the present year. From this report it appeared that an area of approximately 96,000 acres could be reclaimed for the sum of $433,675 and our engineer recommended that a complete survey be carried out with a view to the subsequent construction of the necessary works.

The estimated cost of the proposed scheme amounts to $4.70 per acre based upon the total area under consideration, but this cost will probably be higher when the reclaimed land only is considered.

The scheme itself presents little or no engineering difficulty and can be easily carried through as an engineering project. The report of the Dominion Chemist on one soil sample submitted to him for analysis, indicates that the land will be best adapted to hay growing, in the lower portions especially. Another sample was classed as agricultural land of first class quality, but the lands from which the sample was taken are underlain at a very shallow depth with clear gravel and might not, therefore, be of lasting agricultural value.

The area under consideration lies close to Winnipeg, and it would, therefore, cost very little to bring young cattle from the stock yards at Winnipeg in the fall and feed them for, say, three or four months during the winter, taking them back to the stock yards in the spring as fat cattle.

Unfortunately the greater part of this area has been disposed of to private parties, and unless arrangements can be arrived at whereby transfers may be effected in favour of the Government, no further action by the Federal Government can be recommended.

SASKATCHEWAN

Waterhen Lakes Project, Townships 44, 45, 45a, Ranges 21 and 22, W. 2nd. Meridian

Since 1906 numerous applications have been made to the department for the privilege of draining these lakes and purchasing the available Dominion Land so reclaimed. For a number of reasons the department would not favourably consider any of these applications but in one way or another considerable information regarding the project was gained by the Reclamation Service, and it was decided in the fall of 1918 to carry on a reconnaissance survey to determine its desirability and feasibility.

The district surrounding these lakes is closely settled and is situated on the Prince Albert-Winnipeg branch of the Canadian National Railway, thus assuring good transportation facilities and easy access to markets.

The reconnaissance survey showed the drainage of the Waterhen lake and marsh to be economically feasible, and the general attitude of the settlers in the district seemed to indicate that it was their desire that this work should be carried out. The beneficial effects of this drainage project will not be confined merely to the actual drainage of the lands now submerged, but will extend to thousands of acres of the surrounding low-lying country, since the water table of the district will be lowered from 5½ to 8 or 10 feet. This will probably mean drier and warmer conditions in spring, earlier farming operations, and less liability to summer frosts. Further, what is now merely slough land growing a coarse variety of grass will become first-class agricultural land, adding greatly to the prosperity of the district, since some 12,000 acres of this land, now absolutely useless, will be reclaimed and made available for the better class of settlers. Kinistino, the nearest market town, some three miles from the lake on the railway, should be materially benefited by the increased tributary population and by the better facilities for transportation owing to the improvement and shortening of the roads south of the town.

Since very careful consideration had to be given to the chemical and physical properties of the soil before a decision could be made regarding the feasibility of the drainage project, a considerable number of soil samples were collected and forwarded to the Dominion Chemist for analysis. These analyses indicate that both the physical and chemical properties of the soil are very good indeed and that after drainage and proper aeration this area should become first-class arable land.

As a result of the favourable nature of the reconnaissance investigation, detailed surveys were carried out, during the past season, by one of the large location parties, with a view to the construction of the required works by the Federal Government under Part 3 of the "Reclamation Act, 1917" (Saskatchewan).

These surveys were completed by fall and steps were immediately taken to organize a drainage district in accordance with the drainage laws of Saskatchewan. This district was erected on May 31, 1920, and designated as "Drainage District No. 18."

Tenders have now been called for the construction work, which will be carried out by contract under the direct supervision of the Reclamation Service.

Moose Range Drainage Project, Tps. 48, 49, 50, and 51, Rges. 9 to 15, W. 2nd Meridian

The attention of the Reclamation Service was first drawn to this district in 1914 when the province of Saskatchewan suggested the necessity for the drainage of lands in townships 48 and 49—ranges 13 to 15 W. 2nd M., in order that roads might be constructed through the district to enable the settlers to reach the nearest market town of the district—Tisdale, Sask.

Petitions were forwarded to the Provincial Government asking that they undertake this drainage work, but war-time conditions prevented the actual undertaking of this project.

As a result of the abnormal rainfall in the years 1915-16, practically the entire district became more or less flooded, and in the spring of 1917 a petition was received in this department signed by 72 settlers controlling some 11,000 acres of land in the district, asking that steps be taken to drain the land, as otherwise they would be obliged to move out and suffer considerable loss. It was represented that owing to the flooded condition of the land in the early part of the season it was impossible to work it and that it could not be seeded in time for the crops to ripen before frost.

This statement of conditions was largely confirmed by inspections made by homestead inspectors and Dominion land surveyors, and upon the organization of the Drainage Division of the Reclamation Service it was decided to make a reconnaissance survey of this tract to determine the feasibility or otherwise of draining it.

A reconnaissance party went into the district in July to ascertain what lands should be included in the project and to gather particulars regarding the general topographical features, soil characteristics, vegetation, climatic conditions, slope of the country, views of the settlers, existence of drainage outlets, and any other particulars which might be pertinent to the investigation.

The reports submitted show that some of the land requiring drainage is too wet for anything but the growth of wild grasses of which, although they grow in great luxuriance, only a small proportion can be harvested. Other parts of the tract are so flat that beaver dams, by preventing natural drainage, have created a wet floating muskeg or morass. Viewed from a distance, the country has the appearance of very rich hay meadows but upon close inspection is found to be utterly useless in its present condition for grazing or cropping. The soil, which is apparently free from alkali, is generally a rich black loam with a clay, clay-loam or sand-loam subsoil and properly drained would probably be very fine agricultural land.

As the settlers in the district are practically unanimous in favour of drainage, and as the preliminary reports of the project are favourable, it was decided to make location surveys to determine definitely the boundaries of the tract, and obtain such additional information as is required to enable a close estimate of the cost to be made. The preliminary survey shows that the reclaimable area is approximately 80,000 acres and that the cost of drainage will probably not exceed $5 per acre. No definite statements on these points can, however, be made until the final surveys are completed.

Ponass Lake, Tps. 37, 38, 39 and 40, Rges. 14 and 15, W. 2nd Meridian

During recent years numerous representations have been made to the department by settlers in this district and by others that the land surrounding and underlying Ponass lake in central Saskatchewan should be drained, and petitions have been received both by the Provincial and Federal Governments asking that the settlers be relieved by lowering or completely draining the lake. Some inspections and partial reconnaissance surveys were undertaken by both the Provincial and Federal Governments with a view to determining what steps should be taken, but none of these were sufficiently complete to give an adequate idea of the cost of the work or the area of land which could be reclaimed. It was, therefore, decided to make a complete survey, and after the completion of the surveys of the Waterhen lakes, the location party was moved to this district for the purpose of finally determining the advisability or otherwise of undertaking the drainage of this lake and the surrounding district.

The land in general throughout the district is slightly rolling and is cut by many sloughs leading from Ponass lake proper, which is much cut up by peninsulas and islands and is, at low water, rather a series of separate sloughs and small lakes than a single lake. The general depth of the water varies from two to four feet, except in the southwest corner where it reaches a depth of eight feet. During the year 1919 only about 60 per cent of the bed of the lake was actually water-covered, the remainder being suitable for hay and grazing, but during the years 1912 and 1913, when the water

was abnormally high, it reached a level of approximately five feet above last year's level and covered all this hay land and, in addition, a great deal of the land owned by the settlers of the district.

From the reconnaissance surveys and the information otherwise available, it appeared that there was a possibility of draining this lake to the northward, thus avoiding the long canal necessary to carry it through Quill lakes and thence to Last Mountain lake, but upon running a line of levels it was found that the land in township 39, range 15, west of the 2nd meridian, rises rapidly to the northward, reaching a height of eighteen feet above the lake level at a distance of seven and one-half miles north. This renders the constructing of a canal draining Ponass lake to the north impracticable on account of the prohibitive cost.

The natural outlet of the district is south by Clair creek, leading from the southwest arm of Ponass lake through a chain of sloughs some eighteen miles long to Little Quill lake. While there is another outlet from the southeast arm via Pasweigan creek into Little Quill lake, the former outlet is a much more clearly defined watercourse with a more rapid drop, making construction through it less costly.

The only uncertain feature in connection with this outlet is the effect which the water drained from Ponass Lake district will have on the level of the Quill lakes. It is possible that the level of the latter lakes might be raised sufficiently to cause damage to the lands around these lakes. An investigation made in 1914 by the Board of Highway Commissioners of Saskatchewan showed that, while the water was five feet above normal during the years 1912-13 and did some damage to the land bordering the lakes, these were the only two years in which such abnormal high water occurred. Our engineers are of opinion that this condition would have been little, if any, worse had the proposed canal from Ponass lake been in operation.

To carry the waters onward through Quill lakes to Last Mountain lake would require the construction of a canal forty miles in length, with cuttings varying from five to ten feet and would render the drainage of Ponass lake too expensive to be considered as a practicable proposition.

The property owners throughout the district, when interviewed by our engineers, expressed themselves as very much in favour of the proposed porject and all appeared anxious to see it undertaken. There is little doubt that the advantages of drainage in this district would not be confined to the owners of lands bordering the lakes and sloughs within the district itself, but the general lowering of the water-table would be of great benefit to many settlers for a considerable distance from the main lakes and sloughs, and would also provide a suitable outlet for the subsidiary drainage of numerous small lakes lying within the boundaries of quarter-sections at present owned by the settlers.

The district is overlaid to a depth of approximately six inches with a rich vegetable mould, well decomposed and mellow, resting upon a plastic, moderately stiff and somewhat gritty yellowish clay. This soil has a considerable impregnation of alkali but, in the opinion of the Dominion Chemist, is well worthy of reclamation if, by this means, the saline content may be lowered.

Four possible projects were investigated. These are designated as Schemes A, B, C and D, the cost per acre of reclamation being $14.13, $14.63, $13.17 and $16.01, respectively.

Scheme A—Of the total area of land, amounting to 25,548 acres, of which 13,812 acres are vacant or Crown lands, 16,537 acres will be directly benefited by drainage. The estimated cost of this project, as determined by the surveys made last summer, is approximately $234,000.

Scheme B—This includes the area covered by Scheme A and, in addition, the area to the north which drains into Ponass lake in the east half of township 39, range

15, and the southeast part of township 40, range 15. The total area is 35,448 acres, of which 18,215 acres are vacant or Crown land; 19,640 acres will be directly benefited by drainage. The estimated cost of this project is $287,000.

Scheme C—This includes the area covered by Schemes A and B and, in addition, a large part of the west half of township 39, range 15, and the southwest part of township 40, range 15. The total area is 42,420 acres, of which 22,404 acres are vacant or Crown land; 23,497 acres will be directly benefited by drainage. The estimated cost is $309,400.

Scheme D—This includes the reclamation of all the land included in Scheme C, but the water in the north and northwest part of the district is proposed to be diverted north into Echo lake. The total area of land is 42,420 acres, of which 22,404 acres are vacant or Crown land; 23,497 acres will be directly benefited by drainage. The estimated cost is $376,000.

Further surveys are being conducted this season to determine whether or not an outlet can be obtained to the Barrier river by a line run northwest from Ponass lake. Some of the levels taken last year indicated that this might be possible.

Carrot River Triangle lying between the Carrot and Saskatchewan Rivers, and the Sipanok Channel

Several partial preliminary investigations have been made through this district, which comprises some 727,000 acres of land subject to periodical flooding. These investigations showed the feasibility of an extensive drainage project and indicated that the land naturally divides into two parts, roughly equal in area, the western one being reclaimable by gravity ditches alone, while the eastern will require the installation of a pumping plant.

A hurried reconnaissance was made by one of our engineers in December last. From his observations and such information as he secured locally, he classified the area of the Carrot River triangle as follows:—

1. *Timber lands*—Belts of heavy timber varying from a few hundred feet to a mile in width follow the banks of the Carrot, Sipanok and Saskatchewan rivers. The timber consists of spruce, birch, cottonwood and balsam with some ash and elm. The spruce is particularly fine.

The timber belt extends southerly from Carrot river to the Pasquia hills with very few open places of muskeg or hay meadows.

2. *Open lands*—Between the Carrot, Sipanok and Saskatchewan rivers, after the narrow belt of timber is passed, the area consists of open muskeg, grass lands and shallow lakes with occasional narrow strips or islands of timber and brush along the higher ridges and small creeks.

Travel through this open country in summer is extremely difficult on account of bogs and sloughs. In spring, soon after the breakup and at times when the Sipanok and Carrot overflow, it is practically impossible to travel. There are small lakes, sloughs and open water that can be traversed by canoe for short distances, after which come large areas covered with flags, rushes and willows that cannot be navigated and yet are too wet to travel on foot.

Probable value of land when reclaimed—No investigation of the soil of this district has been made, as far as known, but the luxuriant growth of hay, the rank growth of weeds and success of the garden at the Finger Lumber Company's farm, indicate that the soil will prove rich and productive.

Further surveys—At present the matter of continuing surveys of this project are in abeyance pending enactment by the Government of the province of Manitoba

of drainage legislation similar to that passed by the provinces of Alberta and Saskatchewan. As soon as this legislation is passed and suitable arrangements can be made with the provincial authorities, it is recommended that complete surveys be undertaken with a view to future construction of drainage works.

ALBERTA

Beaverhills lake in Tps. 50, 51, 52 and 53, Rges 17 and 18, W. 4th Meridian

The investigation of the Beaverhills Lake Drainage Project was carried out by the late Major W. F. Graham, who died a few days after the completion of the surveys, and although no report was submitted by him, the notes, maps and plans made in the field and the data collected were sufficient to enable Mr. J. S. Tempest, Supervising Hydraulic Engineer, to prepare and submit an estimate of the cost and to report fully on the project. The following is a summary of Mr. Tempest's report:—

Beaverhills lake is a comparatively shallow body of water, covering approximately eighty square miles. The shores are low and flat and consequently a slight rise or fall in the lake level is sufficient to flood large areas of land which are productive of large quantities of coarse hay. In dry years this hay can be cut, but in wet seasons cropping is impossible on account of the wet, boggy nature of the ground. Even in dry seasons when the lake is low the water is sometimes piled up in the long narrow bays by strong northwest winds which sweep unchecked across the lake. Moreover, several years ago, dams were constructed in the bed of the outlet creek which evidently caused a silt bar to form at the outlet of the lake causing the level to rise above normal and damage hay meadows formerly free from flooding under normal conditions.

There is a general sentiment among settlers in the vicinity favouring the lowering of the lake to about the elevation of the water in the dry season of 1919 and some even advocate complete drainage. It is doubtful, however, whether complete drainage would be advisable, even if practicable, which it is not on account of enormous cost, as the waters of the lake are less alkaline than neighbouring wells, and are of very appreciable value for stock-watering purposes. The principal opposition to the lowering of the lake level comes from settlers who depend upon the lake as a source of stock-water, but whose lands do not abut upon it.

The most feasible scheme is to lower the lake 7·85 feet, by which some 20,000 acres could be reclaimed at an average cost of $17.07 per acre.

Several different plans were projected and the costs and benefits computed, resulting in a recommendation that this project be left in abeyance for the present while attention is being given to others more profitable.

Bittern lake in Tps. 46 and 47, Rges. 21 and 22, W. 4th Meridian

This lake has a superficial area of approximately 12,000 acres. Nine applications have been received since 1912 to drain the lake and purchase the land underlying and adjoining it. Several petitions for and against complete or partial draining were received but, as in other cases of this nature, owing to the absence of definite drainage legislation or of agreement between the Dominion and Provincial Governments, none of these applications could be given favourable consideration.

Immediately to the north of Bittern lake is Big Hay lake, which is little smaller in area although considerably shallower. The natural outlet from this lake is to Bittern lake by way of a smaller connecting lake—Adrian lake. To provide for the cutting and making of larger quantities of wild hay on the foreshore of this lake some unauthorized cleaning out of the connecting creeks was undertaken by a few

of the settlers, with the result that more than the normal quantity of water reached Bittern lake and flooded the lower lying shores, causing protests from the riparian owners concerned, since Bittern lake has no outlet.

The draining of these lakes is so closely related that no steps should be taken to drain Big Hay lake without making adequate provision for disposing of the water diverted to Bittern lake, or else without lowering the level or completely draining the latter.

Because of the great interest manifested by the local people and of the steps taken by them to organize a drainage district in the Big Hay Lake district, it was decided to make a complete investigation of the desirability and feasibility of draining Bittern lake, partially or completely, under the provisions of Part IV of the Drainage Regulations. A field party was engaged in this work from May 5 to June 23, 1919. Simultaneously the Provincial Government undertook the investigation of the Big Hay Lake scheme with a view to the erection of a drainage district under the provincial drainage laws.

Bittern lake was completely traversed and contours determined to two-foot intervals; canals were projected and estimates of cost submitted for five possible developments. The only engineering feature of any importance that presented itself was the provision of a safe and adequate outlet from Bittern lake to Battle river, the total fall being 155 feet in a distance of approximately two miles, of which a fall of 131 feet occurs in a distance of 600 feet. A timber chute is considered to be the most desirable type of structure to carry the water at this point.

It was determined that an outlet can be provided for draining Big Hay lake, without altering the level of Bittern lake, at an estimated cost of from $20,000 to $25,000, while the waters of Bittern lake can be lowered 4½, 8½, 12½ feet, or completely drained, at an average cost per acre of approximately $18, $16, $12, or $13.50 respectively. The areas reclaimable are 3,000 acres, 4,700 acres, 8,400 acres, and 12,000 acres, respectively. Since a portion of the cost of this project would be properly chargeable to the Big Hay Lakes drainage district, by the provision of an outlet for the drainage from that district, the cost per acre as estimated above would be considerably decreased should both projects be constructed.

A sample of the water of Bittern lake was analyzed by the Dominion Chemist and was found to contain a fairly strong, though not excessive, impregnation of "alkali." This was to be expected, as in the absence of an outlet, this lake has acted as a sump for the surrounding country from which the only loss is by evaporation. In years of more generous precipitation the water would be decidedly less saline. An analysis was also made of soil samples obtained from the bed of the lake which disclosed a decidedly high saline impregnation. As this, however, consists largely of the sulphates of soda and is devoid of carbonates, it is probable that, if effective drainage is possible, the area can be successfully farmed.

The only development of this project that appears desirable as a Dominion Government undertaking is the lowering of the level of Bittern lake 4½ feet, but since more than 50 per cent of the land affected is in private ownership further action can only be taken by the locally interested landowners by the formation of a drainage district under the laws of the province.

Smoky lake, in Tps. 59 and 60, Rges. 18 and 19, W. 4th Meridian

This body of water is eight miles in length, approximately one and a half miles wide and averages eight feet in depth.

Several applications to drain this lake were received in the department and steps were taken by the settlers to erect a district under the provincial drainage laws but circumstances apparently forced the matter to a premature close. However, in view of the magnitude of the project, an investigation was made by the Reclamation

Service in October, 1919, to determine its feasibility and the desirability of constructing it as a Dominion scheme under the provisions of Part IV of the Drainage Regulations.

The district adjoining this lake is rolling and heavily wooded. All of the farms, however, have been cleared of their timber. The soil is good and crops were observed to be well above the average. No indications of alkali were seen. The land at the northern and southern ends of the lake is low-lying and inclined to be of a muskeg character, while the eastern and western shores are sharply defined and extend back into high and rolling country. The outlet from Smoky lake is a creek of the same name flowing from the southerly end of the lake in a southeasterly direction till it joins the North Saskatchewan river about ten miles away. This creek flows in a deep and well-defined channel and will provide an adequate outlet for any contemplated drainage of the lake. For the first four miles there is but a slight fall; in the remainder the fall is quite rapid but not so great as to cause any damage to the channel even if a considerable quantity of water is discharged through it.

The estimated cost of completely draining Smoky lake was found to be prohibitive. A cut, five miles long and from 12 to 20 feet deep, in addition to a main ditch 12 miles in length and 7 miles of lateral ditches, would be necessary for this purpose.

Practically all of the riparian landowners were found to be in favour of partially draining the lake. After lowering its level approximately 5½ feet a supply of water would still be available for stock-watering purposes and at the same time hay could be obtained on the border land in much greater quantities than at present.

It was estimated that this scheme would cost $35,537. At an average cost per acre of approximately $9, 3,933 acres would be benefited. As land in the vicinity of the lake has a value of $15 per acre on the average, the cost of partial reclamation is quite reasonable, considering also that the land to be drained is of even surface and would, when reclaimed, be practically ready for the plough.

Although this scheme is economically feasible it is not one that the Federal Government may undertake as more than 50 per cent of the land affected has passed into private ownership. The initiative now rests entirely with the settlers, who, if they desire, may erect a drainage district under the Drainage Act of the province and proceed with the partial draining of the lake.

Cooking, Hastings and Sisib lakes, in Tps. 50, 51 and 52, Rges. 20, 21 and 22, W. 4th Meridian

Many petitions for and against the drainage of these lakes, or the straightening and deepening of the connecting streams, have been received by the department. A survey, made to determine whether or not such a project would be beneficial or otherwise to the district, showed that the disadvantages would more than counterbalance the advantages to be gained by the drainage of these areas.

Winagami and Kimiwan lakes, in Tps. 76, 77, 78 and 79, Rges. 18, 19 and 20, W. 5th Meridian

A number of applications to drain these lakes and to purchase the land underlying them have been received in the department during the past eight or ten years. For various reasons none of these were accepted and it was eventually decided to have a reconnaissance survey carried out in order that the department might be in a position to judge whether or not these projects could be undertaken advantageously by the Dominion Government. The Winagami Lake district is well timbered with poplar, scattered spruce, tamarack and white birch. Hay meadows extend along the shores of the lake and the South Heart river. The soil generally consists of from 2 to 6 inches of black loam over a clay subsoil and gives every indication of being well

adapted to mixed farming. A preliminary investigation was made between November 24 and December 2, 1919, under very severe weather conditions. Sufficient soundings were, however, taken through the ice to enable a contour map of each lake bed to be plotted and considerable data were collected, which indicated the best methods of draining these areas.

Four possible schemes of drainage were investigated and estimates for each were worked out, but in view of the preliminary nature of the investigation it is not considered that these are sufficiently reliable and further surveys are being conducted this season to completely develop these two projects. It is expected that a complete report and estimates showing costs will be available after this season's work.

Flat lake, in Tps. 65 and 66, Rges. 19 and 20, W. 4th Meridian

A number of applications to purchase and reclaim the lands underlying this lake has been made to the department and several reconnaissance surveys have been undertaken by different interested parties. From all reports received it appeared that this project was a very promising one and the location party in Alberta was accordingly instructed to make detailed investigations before the close of the field season.

Owing to the swampy nature of the shores there has been very little settlement, but such farmers as there are in the neighbourhood have expressed themselves as strongly in favour of the proposed drainage project.

The country surrounding the lake is heavily wooded and all the homesteads and farms in the vicinity have to be cleared by fire and axe before being fit for cultivation. The crops in the district last season were excellent, giving evidence of a very rich farming country. To the south of the lake there is a large territory of muskeg quite heavily timbered which is unoccupied at present and is likely to remain so until such time as drainage development takes place in this district. The first step toward this development will be the reclamation of the area underlying Flat lake.

The lake itself is very shallow, the greatest depth being 4½ feet. In consequence of this, only complete reclamation will be sufficient to lower the water table enough to effect reclamation of the land at present forming the shore of the lake.

The total area within the district is 20,270 acres, of which approximately 12,000 acres will be directly benefited by the drainage works. The estimated cost of this work amounts to $101,500.

East and West Prairie rivers in Tps. 67 to 78, Rges. 13 to 19, W. 5th Meridian

In 1914 and 1915 consideration was given by the department to a serious situation which had arisen in the valley of the West Prairie river in townships 73 and 74, range 16, west of the 5th meridian. The immediate cause of this was a solid accumulation of logs, debris, silt, etc., in the bed of the river for a distance of about three miles. This accumulation or jam acted as a dam, backing up the waters of the river over a large area of homesteaded land and menacing the right of way of the Edmonton, Dunvegan and British Columbia Railway.

Officials of the Department of Public Works and of the Reclamation Service made investigations of the conditions and advised, as the best and most economical method of restoring the natural level of the river, that alternative channels be constructed around the jam. They also reported that the conditions were yearly growing worse, and moreover, from information received from Mr. J. L. Cote, Provincial Secretary for Alberta, it appeared that the channel of the East Prairie river was becoming choked in the same manner as that of the West Prairie river, with similar destructive consequences to homesteads and other lands.

In view of these reports, it was decided to make a more detailed investigation into the conditions and an engineer of the Reclamation Service carried out this work last fall

This engineer reported that, to remove the obstructions in the channel of these two rivers would only be a temporary remedy, as the same conditions would be bound to recur under the influence of the same natural causes that have created present conditions. He suggested, as the best method for removing the objectionable conditions, that the course of the river be straightened, but, it appears from later information that the ultimate cause may not be the crookedness of the channels, as at first supposed, but the lowering of the velocity of flow of these two streams at high water periods in Lesser Slave lake and the consequent deposit of silt and collection of debris in the rivers emptying into it.

It was estimated that the cost of straightening the course of the West Prairie river would be out of all proportion to the benefits to be derived, but that subsidiary channels for the waters of the East Prairie river could be constructed at a cost of $73,000 and 5,680 acres reclaimed, at a cost of approximately $12.75 per acre. Pending a further investigation to determine whether or not the backing up of the waters of the Lesser Slave lake into the river channels is the real cause of the trouble, no action is being taken to remedy the conditions complained of.

McLeod River Valley in Tps. 52 to 54, Rges. 13 to 22, W. 5th Meridian, in the Vicinity of Edson, Alta.

From time to time applications from settlers have been received in this department for private drainage schemes and also petitions for departmental action with a view to relieving conditions in this district. In connection with surveys for small drainage projects in this vicinity, engineers of the Reclamation Service submitted reports indicating that some steps should be taken to assist the settlers in the drainage of their lands. A reconnaissance survey was accordingly undertaken last season in an endeavour to determine the best methods of effecting remedial measures.

This survey showed that the lands throughout this district are about one-half wet and one-half dry and that the wet lands are practically covered with timber.

These wet areas are composed almost completely of muskeg, varying in depth from 6 inches to 35 feet and, from all appearances, the soil, after drainage, will not be suitable for the growth of cereals until after a great deal of time and money have been expended in fertilizing and working it.

There is good fall to all muskegs, creeks and rivers in the district, and flooding, in the general sense of the term, is unknown. These muskegs, however, hold water and are usually very wet and spongy. As all the muskeg areas are wooded, a very considerable amount of work would be required before they could be made ready for cultivation. The investigations showed further that there are no continuous or extensive areas which could be included in a comprehensive scheme, and that on the contrary, these muskegs are small and more or less isolated, making it desirable that development should take place through the individual effort of the settlers.

Sullivan lake, in Tps. 34, 35 and 36, Rges. 14 and 15, W. 4th Meridian

A reconnaissance survey of this area was undertaken at the suggestion of Mr. Halladay, M.P., who had received letters from residents in the neighbourhood of the lake, urging that engineers be sent to inquire into the feasibility of the project.

The investigation showed that the lake is very shallow at the south end but deeper toward the north end, and that there would probably be a considerable area which could not be economically drained.

Some 35,000 acres, however, could probably be reclaimed at a reasonable cost, and instructions have been issued that a further examination be made during the present season.

PRIVATE DRAINAGE PROJECTS

Under the provisions of the Reclamation Acts of the provinces of Alberta and Saskatchewan and of the Dominion Government "Drainage Regulations," areas of vacant Dominion land not greater than 1,280 acres, where the estimated cost of reclamation does not exceed $5,000, may be reclaimed by drainage without reference to the provisions of the Private Ditches Acts of these two provinces, under a simplified procedure which has proved very satisfactory to all concerned.

In each such case, an engineer investigates the project to determine its feasibility and desirability and, if it is the wish of the applicant, works for the satisfactory drainage of the land are designed and laid out. The minimum price for land sold in this manner is $1 per acre. The sale price is determined by an official of the department after an examination of the land.

Many settlers who realize the benefits of mixed farming are actively interesting themselves in draining small lakes or sloughs, and are constructing works to lower the level of these, in order that more hay may be harvested off their shores. In some instances control works are installed to hold the water on the land for a short period in the spring for irrigation purposes. It is then let off so as to permit of the cutting and making of the hay. This is the cheapest form of drainage project, as it necessitates the lowering of the water table from one to one and a half feet only. At a later stage when the benefits of this partial reclamation have been secured, the settler may, at a slightly increased cost, deepen his ditches and thoroughly reclaim the land so that it may be cultivated for the production of cereal crops, which require effective drainage of some three to five feet below the surface.

In the musgek districts, notably in the McLeod river valley and adjoining district, a comparatively small part of the land is suitable for producing cereals. As a result, the settlers necessarily depend largely upon mixed farming and stock raising and for this require a larger area than 160 acres each. This class of territory comprises a large proportion of swampy and muskeg land so scattered and broken as to preclude the possibility of any comprehensive scheme or schemes being developed. It presents, therefore, a distinct problem both as regards actual drainage and the treatment of the soil after drainage, since the water-covered or water-soaked soil consists largely of peat or moss underlain by clay. In its present condition, both before and after drainage, it gives little promise of usefulness unless it can be treated by burning, manuring, or other means to improve its physical and chemical properties.

Future development in such districts will, therefore, be slow and will depend largely upon the efforts of individual settlers who wish to add to their present holdings and gradually to reclaim and improve small adjacent areas. Numerous applications are being received to reclaim and purchase such small areas, and it would appear that encouragement and assistance should be given to them. Many experiments will be necessary before the best methods of dealing with this class of soil after reclamation are discovered. It is now being urged that the Federal Government assist to this end by the establishment of an experimental station or farm, on some of the typical muskeg or peat lands. Considering the vast areas of this class of land throughout Canada—not only in the western provinces but also in Ontario and Quebec—experimental work along these lines will be well justified and will be richly repaid, should proper methods of treatment be discovered and demonstrated.

Experimental work with this class of soil has been, and still is, carried on in some of the central northern states of the United States, and in many instances it has been highly successful.

During the year 1919 the engineers of the Reclamation Service inspected, or investigated, thirty-four small projects falling under the provisions of Part I of the Drainage Regulations, as well as two large projects—Kleskun and Low Water lakes—which were authorized prior to the enactment of the Reclamation Acts and issue of the regulations.

During the winter and spring months, 1919-20, sixty-three applications for drainage privileges under Part I of the Reclamation Acts and Drainage Regulations were received, and, of this number thirty-one will be investigated this season; fifteen applications were cancelled, six as the result of the investigations proving the schemes to be undesirable, and nine before the investigation stage had been reached, either voluntarily or because the preliminary requirements of the department were not carried out. In each investigation the departmental engineers endeavour to obtain complete data regarding the character and value of the soil within the area, as well as the engineering features of the project so that the applicant shall not incur needless expense in endeavouring to reclaim land at excessive cost, or which would be valueless after reclamation.

PROVINCIAL DRAINAGE PROJECTS

Drainage districts are organized under the provisions of the Drainage Acts of the various provinces, upon petition by at least two-thirds of the resident owners of land affected. Where more than 50 per cent of the land involved has become alienated from the Crown, the Federal Government by reason of the Dominion Government Regulations, may not proceed with drainage, and in this case the initiative rests with the settlers. As, however, the control of all water areas is vested in the Crown, in the right of the Dominion, plans of the schemes are required to be filed in this department, and an investigation by one of the engineers of the Reclamation Service is required before the department's approval may be granted.

The following provincial drainage schemes of this class were inspected in 1919:—

Alberta—

District No. 6—authorized August 20, 1919.
District No. 7—authorized October 1, 1919.
District No. 8—authorized January 20, 1920.
District No. 4—authorized January 22, 1920.

Saskatchewan—

District No. 17—authorized September 19, 1919.
District No. 13—authorized October 6, 1919.
District No. 15—authorized November 28, 1919.

Increasing interest is being shown throughout the "North Country," in the important question of drainage, and the engineering staff is being greatly taxed to keep up to the work required, especially in connection with the inspections for private schemes, involving the reclamation and purchase of Crown lands or the reclamation of wet areas within the applicant's holdings.

A number of new drainage districts are in process of formation, and, as the public becomes better acquainted with the machinery now in operation in connection with drainage applications, there is little doubt that the rate of increase in such applications will be materially greater.

During the past winter and spring the snowfall and run-off throughout northern Alberta, Saskatchewan and Manitoba were abnormal, and reports of flooding and requests for drainage became more frequent in consequence. In the majority of cases the applicants are ignorant of the proper procedure and considerable correspondence is necessary before such applications are in shape, but it is believed that the carrying through of a large number of projects in the various districts will soon result in acquainting the settlers throughout the "North Country," with the necessary procedure. As a consequence, a large increase in the number of applications to carry on such work is expected.

INTERNATIONAL WATERWAYS TREATY

The division of the waters of the St. Mary and Milk rivers during the past season was again carried out under the provisions of an interim order made by the International Joint Commission, pending a final decision on this important matter by that body.

The flow in these streams and their tributaries during the irrigation season of 1919 was the lowest on record, and the demand for water for irrigation purposes was the greatest yet experienced, both in the valley of the Milk river in Montana and in the Alberta Railway and Irrigation Company's tracts in Alberta. As a consequence of this combination of circumstances the water supply was insufficient to fulfil all demands upon it, but, on the whole, it may be said that the irrigated areas depending upon the main streams for their supply did not suffer seriously. The ever increasing demand for irrigation indicates, however, that serious complications may arise during any year, but it is hoped that some final decision and adjustment may be arrived at before any serious dispute arises.

LIST OF PUBLICATIONS OF THE RECLAMATION SERVICE.

Drainage Regulations.

Irrigation Regulations.

Annual Stream Measurement Report, 1909 to 1918.

Annual Irrigation Report, 1906 to 1915.

Irrigation Surveys and Inspections Report, 1915; (1915-16); (1916-17); (1917-18); (1918-19).

Western Canada Irrigation Association Report (1st to 11th Convention).

International Irrigation Congress Report (1914).

Bulletin No. 1, Irrigation in Saskatchewan and Alberta.

Bulletin No. 2, Alfalfa Culture.

Bulletin No. 3 Climatic and Soil Conditions, C.P.R. Irr. Block.

Bulletin No. 4, Duty of Water Experiments and Farm Demonstration Work.

Bulletin No. 5, Farm Water Supply.

PAMPHLETS.

Address by S. G. Porter: "Practical Operation of Irrigation Works"; Extract from W.C.I.A. Report, 1914.

" " Dr. Rutherford: "Inter-dependence of Farm and City"; Extract from W.C.I.A. Report, 1914.

" " Mr. Don. H. Bark: "The Actual Problem that Confronts the Irrigator." Extract from W.C.I.A. Report, 1914.

" " Mr. Don. H. Bark: "Practical Irrigation Hints for Alberta"; Extract from W.C.I.A. Report, 1915.

" " Mr. Don. H. Bark: "Alfalfa Growing"; Extract from W.C.I.A. Report, 1915.

DEPARTMENT OF THE INTERIOR, CANADA

Hon. Sir JAMES LOUGHEED, Minister; W. W. CORY, Deputy Minister

Reclamation Service—E. F. DRAKE, Director

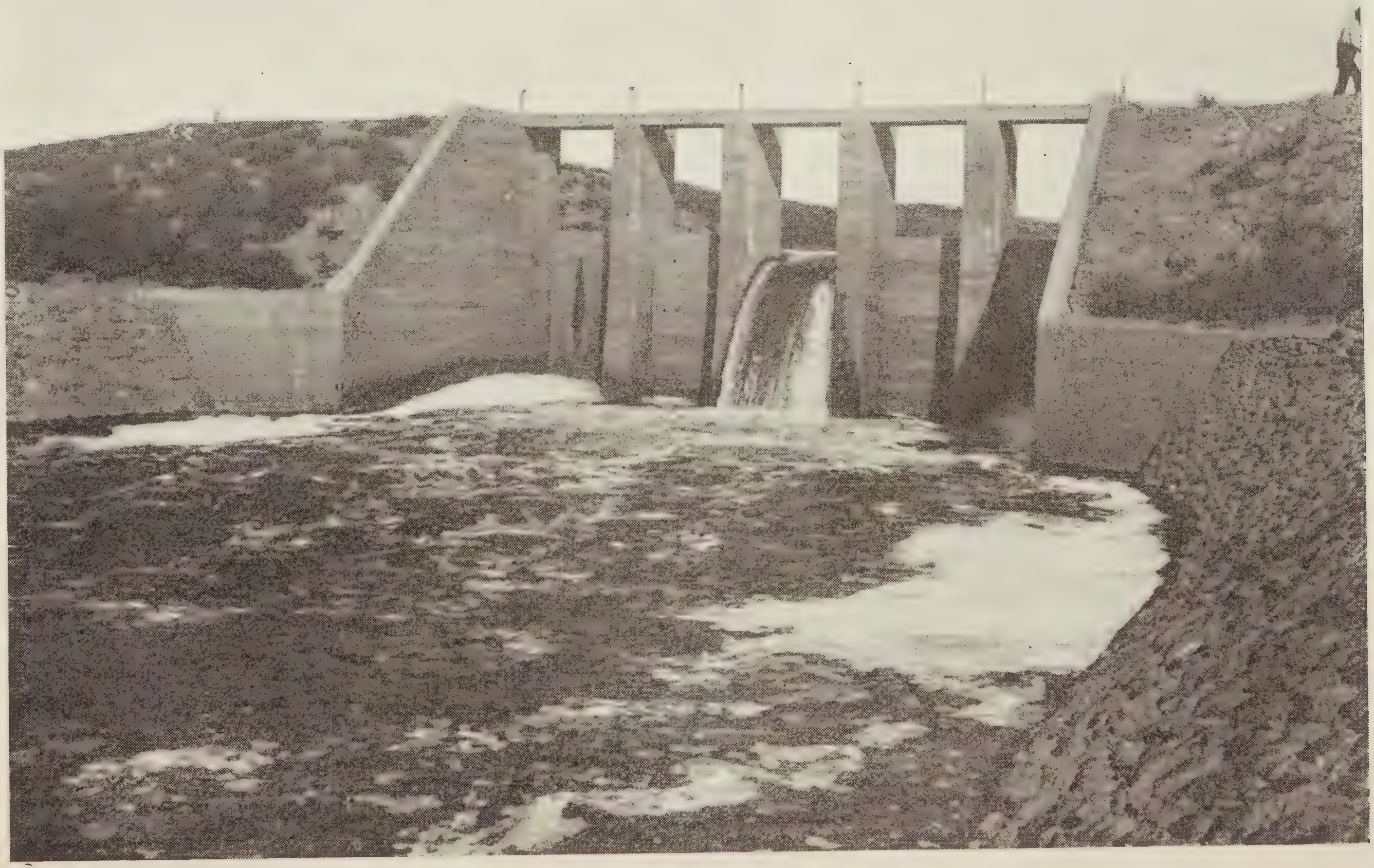
ANNUAL REPORT

OF THE

RECLAMATION SERVICE

1920-21

OTTAWA
F. A. ACLAND
PRINTER TO THE KING'S MOST EXCELLENT MAJESTY
1921



Drop 5—Canada Land and Irrigation Company Canal.
(The construction of this canal was commenced in 1909 and was operated for the first time on April 29, 1920.)

DEPARTMENT OF THE INTERIOR, CANADA
Hon. Sir JAMES LOUGHEED, Minister ; W. W. CORY, Deputy Minister
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TABLE OF CONTENTS

Plan

RECLAMATION

REPORT OF THE DIRECTOR OF THE RECLAMATION SERVICE, E. F. DRAKE

CLIMATIC AND CROP CONDITIONS FOR 1920

In the semi-arid belt of Alberta and Saskatchewan another dry year has been experienced, making the fourth in succession; 1917 and 1918 were dry years, 1919 was even drier and owing to the decreasing stores of moisture in the ground, crops were practically a complete failure except where irrigation was practised. The year 1920 has been but little better than the preceding years.

The winter of 1919-20 was mild, with the exception of a cold snap in the beginning of December and another near the end of January; there was fairly heavy snowfall but Chinook winds melted the snow quickly. The weather was thus ideal for wintering stock but, unfortunately, owing to the drought in 1919, there was an acute shortage of feed, and cattle losses were heavy. Spring ploughing was delayed by a heavy snowstorm on March 30 and in April there was exceptionally heavy rainfall, amounting in all to 4·37 inches. At the beginning of May the ground was so wet that it was impossible to engage in farm operations and much of the seeding was not completed until the end of the month. The following months were warm and very dry. In June there were strong winds and considerable soil drifting in certain areas with a consequent loss of about seventy-five per cent of the crop. Up to the middle of August grains and roots generally gave promise of a fair crop, but they could not stand the continued drought and gradually burned up. Another poor crop was the result. The rainfall from June to December was much below normal and the soil was so dry that fall ploughing and work on the land became almost impossible. It was another very disappointing year to the farmer and when winter commenced there was no accumulation of moisture in the soil.

In the two tables which follow, it has been the endeavour to show the relationship between rainfall and yields of certain field crops in Alberta and Saskatchewan. The value of these tables is only comparative, for the crop yields shown cover the entire province without regard to the boundaries of the semi-arid area, while the rainfall records are those recorded at two points only; also no account has been taken of rust, hail, insect pests or other conditions which affect crops in localized areas. Nevertheless, it is clearly shown that there is direct connection between precipitation and yield and that crop yield fluctuates in much the same ratio as rainfall. The results shown in these tables, while true of the province as a whole, do not fairly represent conditions in the semi-arid area where, as already stated, crop results for the most part were very disappointing. It is a fact, however, that in the semi-arid tract, since 1915—a year of unusual rainfall and abundant crops—the precipitation and crop yield have both been considerably below normal because as the stored moisture in the soil decreased as a result of the succession of dry years, the fertility of the land was proportionately reduced.

TABLE SHOWING YIELD OF WHEAT, OATS AND BARLEY, FOR THE YEARS 1915–16–17–18–19–20.

ALBERTA

Crop and Year	Yield per Acre	Average price per Bushel	Average price per acre		Yield per Acre	Rainfall at Calgary, April to August	
	Bush.	$	$	%	%	Inches	%
Wheat—							
Normal	22·50[1]	1 00[2]	22 50	100	100	11·56[3]	100
1915	31·12	88	27 39	122	138	12·27	106
1916	24·99	1 33	33 24	148	111	8·93	77
1917	18·25	1 74	31 73	141	86	6·63	57
1918	6·00	1 92	11 71	52	27[4]	5·78	50
1919	8·00	2 31	18 66	83	36	7·49	65
1920	20·50	1 52	31 16	138	91	9·42	82
Oats—							
Normal	42·00[1]	34[2]	14 28	100	100	....	....
1915	45·91	31	13 97	98	109	....	....
1916	48·11	46	22 13	155	115	....	....
1917	34·00	63	21 42	150	81	....	....
1918	22·75	73	16 61	116	54	....	....
1919	23·75	64	15 20	106	54	....	....
1920	37·25	36	13 41	93	88	....	....
Barley—							
Normal	28·25[1]	50[2]	14 12	100	100	....	....
1915	32·31	44	14 27	101	114	....	....
1916	29·04	71	20 62	146	103	....	....
1917	22·00	98	21 56	153	78	....	....
1918	16·50	97	16 00	113	58	....	....
1919	25·50	1 09	27 79	198	99	....	....
1920	26·50	62	16 43	117	93	....	....

[1]Average for ten years 1908–17. [2]Estimated. [3]Average for 30 years 1885–1914. [4]Results affected by frost 25th July, 1918.

TABLE SHOWING YIELD OF WHEAT, OATS AND BARLEY, FOR THE YEARS 1915–16–17–18–19–20.

SASKATCHEWAN

Crop and Year	Yield per acre	Average price per Bushel	Average price per acre		Yield per acre	Rainfall at Swift Current, April to August	
	Bush.	$	$	%	%	Inches	%
Wheat—							
Normal	18·50[1]	1 00[2]	18 50	100	100	10·03[3]	100
1915	25·12	91	22 86	124	136	10·14	101
1916	16·34	1 28	20 92	113	88[4]	14·09	141
1917	14·25	1 95	27 79	150	77	5·12	51
1918	10·00	1 99	20 00	108	54[5]	5·62	56
1919	8·50	2 32	19 72	107	46	7·38	74
1920	11·25	1 55	17 43	94	61	7·92	79
Oats—							
Normal	38·25[1]	34[2]	13 00	100	100	....	....
1915	43·48	32	13 72	106	114	....	....
1916	43·06	46	19 81	152	113	....	....
1917	27·25	62	16 90	130	71	....	....
1918	21·50	70	15 05	116	56	....	....
1919	23·10	70	16 23	125	63	....	....
1920	27·70	41	11 36	87	72	....	....
Barley—							
Normal	26·75[1]	50[2]	13 38	100	100	....	....
1915	31·74	46	14 64	109	119	....	....
1916	27·00	77	20 79	155	101	....	....
1917	21·00	1 00	21 43	157	79	....	....
1918	17·00	88	14 96	112	67	....	....
1919	18·20	1 08	19 66	147	68	....	....
1920	20·25	66	13 35	100	75	....	....

[1]Average for ten years 1908–1917. [2]Estimated. [3]Average for 30 years 1885–1914. [4]Results affected by rust. [5]Results affected by frost 25th July, 1918.

IRRIGATION

The year 1920 has been the fourth dry year in succession in the semi-arid area of southern Alberta and southwestern Saskatchewan. As a result the settlers are becoming insistent in their demands for irrigation as the only remedy for the insufficient rainfall and blowing away of the light top soil by the frequent heavy winds.

The Dominion Government, which administers the surface water supply in the Prairie Provinces, knowing that the available supply is not nearly sufficient to serve all the lands which need irrigation, has always endeavoured to see that appropriated water was put to beneficial use and not wasted. As one dry year followed another and the necessity and value of water for irrigation purposes became more and more apparent, this policy led to the making of extensive surveys to determine the lands best suited for irrigation and to discover the best method of serving them. This, in turn, made necessary the investigation and study of stream flow and storage possibilities. Then in order to make it possible for the farmers living in irrigable areas to co-operate and organize into irrigation districts, the Government, through its Reclamation Service, went further and made complete surveys of a number of tracts, designed the canal systems to serve them, and prepared preliminary plans and estimates of the cost of the required works. All this information was turned over to the people in the districts as soon as they were organized sufficiently to use it. To insure the allotment of water to lands where it would do most good and to protect the extensive surveys completed and under way, an Order in Council was passed on September 6, 1919, reserving the unappropriated waters of certain rivers and streams in southern Alberta until investigations could be completed over the whole area tributary to them to determine where and how these waters could best be applied to beneficial use.

In 1919 negotiations took place between the Minister of the Interior and the Government of the province of Alberta in order that a definite understanding might be arrived at as to the responsibility of each for the survey and further development of irrigation projects within the province. As a result it was decided that the Federal Government would continue to make surveys and exercise supervision as heretofore, but would not assume any responsibility for actual irrigation development beyond this. The Provincial Government, having this assurance from the Dominion, has interested itself in development beyond this point and by passing a new Irrigation Districts Act in 1920 (amended at the session of 1921) and by appointing an irrigation council to supervise and assist in the development of districts, has made it easy for settlers in any area, after they have been assured of the willingness of the Dominion Government to grant a water right, to organize and proceed with the necessary development. Under the provisions of the Act above referred to, several districts were erected in 1920 but a difficulty occurred when one of these, the first to complete preparations and endeavour to raise money for its further development, found that, in spite of the favourable reports of Government and consulting engineers who had investigated the project, it was not possible to sell their irrigation debentures although the lands in the districts were fully pledged as security. The Provincial Government has since made arrangements to guarantee the bonds of this district and of others which may be favourably reported upon by their consulting engineers. This removes the last obstacle and now, with the settlers calling ever more loudly for irrigation, with the line of responsibility between the Dominion and Provincial Governments and the people definitely settled, and with the way to safe and sure financing opened up, there should be substantial development of irrigation in southern Alberta.

In 1919, plane-table surveys were made of a number of irrigable tracts which had been previously located, and comprehensive investigations and studies were made to determine the best methods of storing and distributing flood waters to serve these

areas. This work was continued in 1920, when nineteen survey and inspection parties which were sent into the field obtained information that will permit of the working up and designing of several large projects.

The following projects, which have been completed and are in full or partial operation, not only serve as object lessons of the advantages of irrigation, but are producing crops and feed each year which are helping greatly to stabilize conditions throughout the whole of the semi-arid district:—

Canadian Pacific Railway Projects:—		
Western Section, irrigable	221,000 ac.	
Eastern Section, irrigable	400,000 ac.	
Lethbridge Section, irrigable	130,000 ac.	
Canada Land and Irrigation Co., irrigable	202,000 ac.	
Taber Irrigation District, irrigable	17,000 ac.	
Private projects (small), irrigable	106,000 ac.	
Total		1,076,000 ac.

Surveys, reports and estimates have been completed by the Reclamation Service in the following districts, the settlers of which hope to be able to commence construction work during 1921:—

*Lethbridge, Northern Irrigation District to irrigate	105,000 ac.	
United Irrigation District to irrigate	23,000 ac.	
Medicine Hat, Southern District to irrigate	5,400 ac.	
Medicine Hat, Eastern District to irrigate	5,000 ac.	
Macleod District	80,000 ac. (estimated).	
Total		218,400 ac.

Surveys have been made and estimates worked up in the following districts in which active organization is only in its preliminary stages:—

Retlaw-Lomond, to irrigate approximately	100,000 ac.	
Lethbridge, Southeastern, to irrigate approximately	350,000 ac.	
Barons-Carmangay, to irrigate approximately	18,000 ac.	
Rocky-Coulee to irrigate approximately	12,000 ac.	
Total		480,000 ac.

Survey work under way but not completed includes the plane tabling of certain comparatively small areas in the Lethbridge Southeastern project and the final survey of several small projects lying west of the town of Pincher Creek, preliminary surveys of which were made in 1920. Surveys of very large tracts of land lying north of Red Deer river and south and west of the city of Saskatoon, in what is known as the North Saskatchewan project, are also under way. Reconnaissance, location and level parties will do considerable development work in this district during the present field season.

The work done in each district is outlined more fully in the report of the Acting Commissioner of Irrigation, which is submitted herewith.

HYDROMETRIC SURVEYS

Pursuant to the policy of the department to consolidate and co-ordinate the work of its various branches, the work of hydrometric surveys in the provinces of Alberta and Saskatchewan was transferred on July 1, 1920, to the Dominion Water Power Branch, while the Reclamation Service was made responsible for federal interests pertaining to reclamation (both irrigation and drainage) in British Columbia and Manitoba. This rearrangement of responsibility in connection with hydrometric surveys and reclamation work has made possible a higher degree of specialization of work and standardization of methods, with consequent economy and satisfaction to the Government and the public. The transfer of hydrometric survey work to the Dominion Water Power Branch involved the transfer of the hydrometric field and office staff of the Reclamation Service and of practically all of the hydrometric equipment, including the rating station at Calgary. The new arrangement provides for the closest possible co-operation between the Reclamation Service and the Water Power Branch in all matters of common interest.

*Now under construction.

DRAINAGE

The year 1920-21 was the second season of the operation of the Drainage Division of the Reclamation Service. Although the provisions and the working of the Federal Reclamation Act and Drainage Regulations and the similar Provincial Reclamation Acts are but beginning to be known by the settlers in Alberta and Saskatchewan, where there are extensive areas of lands requiring drainage, increasing interest is being shown in drainage as evidenced by the numerous applications and petitions that are being received from those desiring to reclaim small areas of swamp lands, and from communities suffering from flooded and wet conditions.

These laws are proving to be admirably adapted to encourage the reclamation and highest development of swamp lands in Alberta and Saskatchewan, more especially in the northern parts where drainage is most necessary. Several districts in which our engineers have made investigations contain as high as 50 per cent of land that is practically worthless until efficiently drained. Much good land that is at present inaccessible except in winter, on account of intervening swamps, cannot be made available for settlement until roads are made possible by the drainage of the adjacent lands. One extensive district, in particular, abounds in abandoned homesteads, and on account of the wet conditions patented homesteads have frequently changed hands during the last four years at prices varying from \$2.50 to \$9.50 per acre. The new owners now realize, as did those before them, the futility of attempting to work their farms at a profit on account of the amount of land that is unproductive through wet conditions and timbered swamps.

These northern areas are best adapted to mixed farming, dairying and cattle raising, and for a farmer to exist, let alone make a decent living, more hay is required than can be obtained on his own homestead. Men engaged in the cattle-raising business have found that, while feed is fairly plentiful for their needs in summer, sufficient hay cannot be found locally to ensure the wintering of their stock. Conditions were such, before the approval of the Drainage Regulations, that farm after farm was abandoned and the raising of cattle was fraught with too many risks to encourage further development. This very common and widespread disappointment and despair of settlers in many localities is now undergoing a change and many who were on the point of leaving the country have been encouraged to stay by the possibility being opened to them of purchasing swamp lands from the Government under conditions of drainage and on terms that appear satisfactory.

Active and energetic drainage pioneers are invaluable for the development and progress of this north country, and every encouragement should be given to expedite the work of drainage reclamation; in fact herein lies the only hope of converting vast and practically worthless areas into profitable farming districts. Although precipitation is commonly abundant for the growth of farm crops in the northern parts of the provinces, the rain does not always come when most needed and it is often found that a system of irrigation or spring flooding can be combined with drainage at little additional cost, thus ensuring an ideal condition—drainage and irrigation hand in hand. This combination of advantages is, wherever possible, receiving the attention it deserves.

Every drainage scheme successfully carried out by a legitimate settler, making his living and home in the district, constitutes a new link in the chain of prosperous development of the country, produces additional revenue to the province and to the railways, and assists in opening up further territory for settlement. Drainage here is in its infancy and the methods encouraged and permitted to-day will have a far-reaching effect on the future development and agricultural character and prosperity of the areas included and associated with the various drainage projects. Surveys are made and plans prepared by experienced drainage engineers who permit no slipshod, inefficient methods. Every scheme is studied and planned with a view

to the best and most economical development of the land involved. No partial reclamation for the sake of saving in cost and labour is permitted where a more truly economical result is obtainable by more costly or extensive works, and many applications have not been favourably considered where the land applied for, formed merely a portion of a more comprehensive scheme, too large or too costly to be efficiently carried out by an individual settler. Such a comprehensive scheme, if found feasible and desirable, would be recommended for the consideration of the Provincial or Federal authorities.

The sale price of Crown lands is always likely to be a controversial point between the Government and the prospective purchaser, but valuation by an experienced engineer, taking into consideration all the conditions relating to quality of soil, proximity to town or railroad, climate and the estimated cost of the necessary drainage works, should be sufficient to ensure a fair deal in the interest of the public and in justice to the applicant. At the present time considerable allowance should be made in favour of the applicant, who is in the position of a pioneer, spending possibly the best period of his life in assisting in the opening up of a new country, experimenting on the best treatment of land after drainage, the best crops to grow and methods of tillage, and the results of whose labours will be a guide and help to others. Many of these districts, though reasonably near a railroad, are quite inaccessible by any kind of vehicle until after freeze-up. Living is commonly accompanied by many discomforts and hardships and the conditions are such that it would be almost criminal to attempt to bring up a family amidst such surroundings. These pioneers are not only reclaiming land that they may make a decent living, but are assisting materially in opening up the country for others, making intercommunication possible, winter and summer alike, and giving an added value to lands in which they have no interest. All this should be considered in fixing the sale price of Crown lands.

Besides the large number of small schemes, twenty-nine large drainage schemes were investigated during the season, eight of which, having proved feasible and in the public interest, have been recommended for construction. Two proved feasible but were not recommended for the present on account of their not being as desirable and urgent as many of the others. Eleven were recommended for further and more detailed investigation. Eight proved to be not feasible or desirable.

Of the two recommended for construction in 1919, one, the Waterhen Lakes Drainage project, is now in course of construction.

The schemes recommended for construction would in the aggregate make available 12,000 acres of land that would be at least of equal value to the best lands in the districts in which they are situated, and on account of the large accumulation of plant food that is commonly found in the beds of lakes and swamps, would probably be of more lasting fertility. The margin of profit from the sale of these lands when reclaimed would, it is estimated, not only defray all expenses of engineering and construction but usually be a source of considerable profit, while the indirect advantages of opening up new territory, making the country more habitable, making good roads possible and improving the agricultural condition of the adjacent lands would be of far-reaching and permanent benefit.

There is great need of more reconnaissance work to ascertain the potential agricultural value of the vast areas still unproductive and largely unsettled lying within reasonable distance of railroads. The reclamation and settlement of these areas would undoubtedly contribute much towards placing the railroads on a paying basis, would encourage the influx of a better class of settlers and would put an end to the uneconomical but too prevalent practice of widely scattered settlement beyond reasonable distance from existing railroads and markets.

Although this report is intended to cover the fiscal year ended March 31, it is but fitting that reference should here be made of the death of Mr. Ralph J. Burley, Assistant Director and Chief Engineer of the Drainage Division of the Reclamation Service, which occurred at Cressy, Ontario, on April 14, 1921.

Mr. Burley entered the service of the department immediately after his graduation in Applied Science from Toronto University in May, 1902. From 1903 to 1916 he was attached to the staff of the Commissioner of Irrigation at Calgary, Alberta, where he acquired a varied and thorough knowledge of all phases of irrigation engineering. In 1916 he was transferred to a wider field of usefulness on the staff of the Superintendent of Irrigation at Ottawa, and in April, 1919, was appointed Assistant Director and Chief Engineer of the then newly organized Drainage Division of the Reclamation Service.

Mr. Burley was a capable engineer of wide experience and sound judgment and his loss to the department and the public service will be seriously felt. His death at the early age of 39 years is deeply regretted.

REPORT ON IRRIGATION SURVEYS AND INSPECTIONS FOR YEAR ENDED MARCH 31, 1921

By V. Meek, B.Sc., A.M.E.I.C.

Following the precedent established during the last two years, a summary only of the reports of various members of the staff is submitted. The originals are on file in the offices of the Reclamation Service at Calgary and Ottawa for the information of those desiring more detailed information regarding the work.

GENERAL

Although the rainfall was not up to normal in southern Alberta this year, it was fairly well distributed during the growing season, making the conditions much more favourable for crop production than during the previous three years. Notwithstanding this the demand for irrigation, as indicated by the applications received, was nearly as great as during the previous year. There were 191 new applications received and recorded this year, as against 206 during 1919-20 which was the largest number ever received during one year.

ORGANIZATION

The work of the office has been heavier this year than during any previous year of its existence. Exclusive of the Hydrometric office, which was transferred to the Water Power Branch of this department on August 1, 1920, the staff during the field-season, when up to full strength, was about 240, but this was reduced to sixty during the winter. In order to accommodate this staff it was found necessary to secure part of the fourth floor of the Lancaster building. This space is now occupied by that part of the field force which came in for the winter and the temporary office party connected with the large surveys, about thirty in all.

WATER ADMINISTRATION

Revision of Records.—Owing to the large amount of current work it has been impossible to make as much progress as was expected in revising old records, but the relative priorities have been determined in consultation with the Ottawa office, and in a short time it should be possible to replace the stream folio register and other books by the new water administration records which will then become the official records of priority.

Water Quantities.—In addition to indicating the priority of a scheme the licenses are required to show the quantity of water which may be diverted and also the rates of flow at which diversion may be made at low, high, and flood stages. In order that these figures may correctly represent the value of a license, exhaustive studies are necessary, based on hydrometric and other records. Preliminary steps have been taken with a view to preparing a run-off map of Alberta and Saskatchewan.

Water Administration Maps.—Large scale maps showing the outlines of irrigation and other schemes are now in preparation and are essential for a proper study of water questions in certain districts. These maps are being traced on sheets corresponding in size to the sectional sheets published by the Surveyor General, but are drawn to a scale of one inch to the mile with index maps to a smaller scale. It is intended to revise these maps as may be necessary from time to time and it is expected that they will be of service to other branches of the department. Blue prints of particular areas can be supplied upon request. Twenty tracings have already been completed in addition to forty rough drafts in process of compilation.

Hydrometric Surveys.—Although the officers and records of the Hydrometric Service are still available for consultation, the recent transfer of this staff to the Water Power Branch will increase the amount of correspondence, especially with regard to gauge height observations and measurements on irrigation ditches. The measurement of ditches will need special attention in the near future, both as a matter of record and for the purpose of field administration.

Diversion Changes.—Owing to physical changes due to various causes it is often necessary to alter the position of the intake of an irrigation scheme or other works constructed under the Irrigation Act. When these changes are of small extent and will not affect other interests it has been the practice to sanction them without much formality, but in recent years there have been several cases where dams have been washed out and pumping schemes have been installed in lieu at a considerable distance from the original intake.

In order that these schemes may be legally reconstructed, provision has now been made by regulation for applications to be made on regular forms and thoroughly investigated to insure that no other interests will be prejudicially affected. It will then be possible to approve these applications either with the original priority or dating from the subsequent application according to the circumstances of each case.

P.C. 1859.—On the 6th September, 1919, an Order in Council was passed (P.C. 1859) reciting the fact that surveys had demonstrated or indicated the feasibility of utilizing practically all the surface water supply in southern Alberta, not otherwise appropriated, in irrigating large areas of land in that district. In view of the inadequacy of water supply to serve all the lands that might be benefited it was considered desirable as a matter of public policy that the available supply should be so allocated as to serve the largest possible area of land to the best advantage and in the most economical manner, having regard to the aridity of the various portions of the district, the cost of delivering water to them, and the carriage losses incidental thereto.

The order reserves all the unappropriated waters of the Oldman river and the Milk river and their tributaries in the province of Alberta, but does not preclude the granting of rights to divert water directly from such streams for domestic, municipal or industrial purposes nor for the irrigation of areas not in excess of 640 acres, when the land to be irrigated is not more than one mile from the source of such diversion and where application is made in accordance with the provisions of the Irrigation Act.

The above order was subsequently confirmed by an amendment to the Irrigation Act. Its practical effect is to protect small schemes by permitting them to be dealt with immediately, while deferring the granting of priority and allocation of water for the larger schemes until they have been thoroughly investigated.

Duty of Water.—The duty of water, or the amount required to irrigate an acre of land, was originally fixed at one-hundredth of a cubic foot per second throughout the irrigation season. This was equal to a depth of about three feet, but the regulations were subsequently amended to provide the equivalent of about two feet depth of water.

In February, 1919, the regulations were further changed to provide for a quantity equal to a depth of eighteen inches on the land, measured at the farmers' headgates. It is not, however, always possible to obtain this quantity of water without the construction of elaborate works at prohibitive cost, and recent practice has been to regard this depth as a limit to the quantity of water which may be granted for irrigation purposes.

It has, however, been understood that no sale of land will be made when the average supply of water is less than the full legal duty on the area required to be irrigated by the regulations for the sale of lands. It has also been required that all large schemes shall provide the full duty of water, but at the present time one or two schemes are under consideration which contemplates a more extensive distribution of the available water. In such cases the licenses and the plans will clearly set forth the limitation in the supply, and storage will be provided so that the supply to the consumers will be suitably distributed throughout the irrigation season, whether for the full duty or a smaller quantity.

Owing to the urgent need for water and the short duration of flow in certain districts grants may now be made on the basis of the quantity which can be diverted through the works as designed and beneficially used during the period of flow available on the stream. Whenever possible dyking is provided and beneficial use can often be made of twelve inches or even eight inches of water for the irrigation season in localities where there is a general scarcity of moisture throughout the year.

In issuing a certificate under section 33 of the Act, "Utilization" is defined as the beneficial use of water for the purpose named in the application.

As the demand for water increases it becomes necessary to limit the grants to practical quantities, both for purposes of administration and in order that the licenses may correctly represent the estimated limit of available supply and the period during which it is generally available. This information is of value to persons who may wish to purchase lands comprising licensed irrigation schemes.

Preferred Purposes.—By an amendment to the Irrigation Act (chapter 37, section 4, 4-5 George V), it was provided that, subject to priority, applications should have precedence in the following order, namely:—

1. Domestic purposes.
2. Municipal purposes.
3. Industrial purposes.
4. Irrigation purposes.
5. "Other" purposes.

A further amendment (chapter 55, section 4, 10-11 George V) provides that upon application the minister may cancel an earlier grant in favour of an application for a purpose having precedence in the foregoing order.

The object of these provisions is to permit a municipality or railway company to acquire a water right by compensating the original appropriator and any other interests which may be affected. Four such applications are now under consideration.

New Applications.—Owing to the exceptionally dry conditions in 1919 there was a very large increase in the number of applications received for purposes covered by the Irrigation Act. These were more than twice the usual quantity and the large increase has been sustained during the year 1920, with no signs of diminution.

Field-Work.—In order to clear up doubtful questions of fact it is necessary to co-operate very closely with the field inspecting engineers, especially during the winter months when questions can be discussed personally. The water administration engineer has, in addition, made four inspection tours during the year.

Future Administration.—The chief object of revising the records and readjusting the existing licenses is to define all water rights as clearly as possible so as to reduce the probability of future disputes between water users.

At the present stage of development the demand for water is not sufficient to justify an elaborate field organization of water masters, but the senior inspecting engineer has been appointed a water master under the authority of section 34 of the Irrigation Act. He has been empowered to receive complaints of alleged improper or excessive use of water, and to inquire into the circumstances of all such cases or other cases which may become known to him and to take such action as may be necessary and legal to remedy grievances.

The duties of a water master are in large measure discretionary, and under the present conditions the inspecting engineers are in the best position to explain the requirements of the Irrigation Act and to advise irrigators as to their respective rights and obligations.

The water administration office staff consists of two engineers, one draughtsman and one clerk-stenographer, working in co-operation with the field inspection staff and is under the supervision of Mr. J. A. Spreckley acting as water administration engineer.

INSPECTION WORK

Special Inspections.—Domestic, municipal, industrial and irrigation. This work was carried out under the immediate supervision of the office engineer, Mr. P. J. Jennings. The office engineer supervises the work of all inspecting engineers and particularly the special inspectors for Alberta and Saskatchewan. He sees that for each tour of inspection the inspections are properly grouped as regards economy of time, travel, expense and the urgency of a special report. During the year the office engineer examined and checked one hundred and ninety-six plans of all descriptions, including fifty-two descriptions of right of way. One thousand four hundred and thirty-six letters dealing with engineering subjects were written and four hundred and sixty-three reports were dealt with.

Mr. Jennings' report outlines the work carried out by the six inspecting engineers acting under his supervision and from the figures quoted the following is a summary:—

North and East Cypress Hills District—Mr. M. H. French—
Inspections—127

South and West Cypress Hills District—Mr. C. M. Moore—
Inspections—150

Calgary and Cardston Districts—Mr. R. H. Goodchild—
Inspections— 63

Alberta Special Inspections—Mr. F. R. Burfield—
Inspections— 94

Saskatchewan Special Inspections—Mr. Angus Smith—
Inspections— 73

Owing to the continued large increase in the number of applications received for water for irrigation purposes and the requests for surveys and plans, the district engineers were unable to inspect old licensed or authorized schemes—unless it happened that they were in the immediate vicinity and had time to spare. During the past year this increase has been maintained and is now more than 100 per cent over any year prior to 1919. A very busy field season for 1921-22 is therefore anticipated.

It has been found necessary to call upon the district engineers for more detailed information regarding watershed areas, boundaries and physical conditions than has been done heretofore, owing to the critical condition of water supply in many of the drainage basins. This naturally entails spending more time on these inspections, but the information obtained is of inestimable value in determining the amount of the grant to be recommended and will constitute a valuable record in connection with future applications in the vicinity.

During the coming year it is proposed to have the district engineers instal ditch gauges on many of the schemes diverting from streams where the supply has apparently been fully appropriated. These gauges if regularly and properly read, will furnish valuable information as to the quantity of water being diverted and act as a check upon the stage of flow during which the diversions occurred. In making a start on this work it is fully realized that many difficulties may have to be solved before satisfactory conditions are attained and reliable information secured. For instance, there is wasted, annually, an enormous quantity of the water which is actually diverted at the headgate. This condition cannot be rectified until the time arrives for carefully administering each drainage basin, which will entail appointments of additional water masters. In some of the drainage basins this time may be said to have arrived, as all available stream flow has been appropriated and many applications remain which cannot, under the existing system of administration, be supplied with even a small quantity of water.

DISTRICT OFFICES

The ever-increasing number of applications for irrigation investigations and surveys has brought up the question of suitable office accommodation for our engineers within the districts where their work lies. Arrangements have therefore been made establishing district offices at Medicine Hat and Lethbridge for the use and convenience of district engineers and the public. These offices have been equipped with the necessary office furniture and equipment to enable our engineers to work up their field notes, draft pencil plans and write their reports.

DOMESTIC WATER SUPPLIES

Scattered throughout the provinces of Alberta and Saskatchewan are a large number of small reservoirs in coulees or on well-defined watercourses, built by the farmers or ranchers entirely on their own property and for purely domestic requirements. The object of these reservoirs is to store a small quantity of the early run-off or storm water from heavy rains. The dams are invariably built on watercourses which have no regular discharge beyond that due to snow or periodical rainstorms and which are dry most of the year. Our inspecting engineers therefore encourage the farmers who have constructed such works to secure water rights under the Irrigation Act. They also explain that while in most cases the existence of the reservoir may not at present interfere with other rights, there is always the possibility of newcomers filing applications for diversion and storage above or below them—which might entirely deprive them of the possibilities for future storage and of the legal means of obtaining any. An estimate of the cost of filing memorials and plans is generally given at this time together with an outline of the proce-

dure to be followed. In most cases the total cost does not exceed twenty dollars, i.e., ten dollars for the license and ten dollars for survey and plans. Advertising is as a general rule waived and the filing of plans can also be waived at the discretion of the minister.

MUNICIPAL WATER CONSUMPTION

Records of the daily water consumption for the principal cities and towns in Alberta and Saskatchewan have been tabulated for each town, and the monthly and yearly averages obtained. No returns have been received from the city of Calgary owing to the fact that their system is mostly a gravity one from the Elbow river and no measuring devices have been installed. Returns for the portion of the city served from the Bow river by means of pumping would not be of particular value as the area so served varies according to conditions at the headworks of the gravity system. Only incomplete returns have been received from the town of Kamsack and these were not considered worthy of inclusion in the yearly summaries.

Cities and Towns in the Province of Alberta—Daily record of water consumption in Imperial gallons for the year 1920.

Month	Bassano						Carmangay					
	Population 1,000						Population 400					
	Daily Average for the Month	Per Head for domestic purposes	Per Head for industrial purposes	Per Head for other purposes	Per Head for all purposes	Unaccounted for	Daily Average for the Month	Per Head for domestic purposes	Per Head for industrial purposes	Per Head for other purposes	Per Head for all purposes	Unaccounted for
January	148,871	....	....	....	148·8	....	12,000	26·5	....	2·9	29·4	....
February	149,827	....	....	....	149·8	....	10,758	25·8	....	1·0	26·8	....
March	168,709	....	....	....	168·7	....	11,600	25·0	....	....	29·0	4·0
April	169,000	....	....	....	169·0	....	14,000	21·5	....	9·3	35·4	4·6
May	157,000	....	....	....	157·0	....	13,200	27·8	....	2·8	31·8	1·2
June	178,500	....	....	....	178·5	....	12,827	28·5	....	....	31·0	2·5
July	171,129	....	....	....	171·1	....	12,800	24·6	....	....	27·9	3·3
August	157,900	....	....	....	157·9	....	12,000	25·0	....	....	30·0	5·0
September	161,166	....	....	....	161·2	....	12,800	29·5	....	1·3	32·4	1·6
October	165,000	....	....	....	165·0	....	12,000	25·5	....	....	27·1	1·6
November	150,000	....	....	....	150·0	....	14,068	27·3	....	5·0	33·9	1·6
December	130,000	....	....	....	130·0	....	11,613	27·4	....	1·6	29·0	....
Av. for year	158,925	....	....	....	158·9	....	12,474	26·2	....	*3·4	30·3	....

* 7 months.

Month	Athabaska					
	Population 400					
	Daily Average for the Month	Per Head for domestic purposes	Per Head for industrial purposes	Per Head for other purposes	Per Head for all purposes	Unaccounted for
January	13,556	33·9	....	....	33·9	....
February	20,215	50·5	....	....	50·5	....
March	18,988	47·4	....	....	47·4	....
April	19,375	48·4	....	....	48·4	....
May	16,572	41·4	....	....	41·4	....
June	21,708	54·2	....	....	54·2	....
July	22,984	57·4	....	....	57·4	....
August	24,960	62·4	....	....	62·4	....
September	16,166	40·4	....	....	40·4	....
October	10,564	26·4	....	....	26·4	....
November	9,625	24·1	....	....	24·1	....
December	18,145	45·3	....	....	45·3	....
Average for year	17,738	44·3	....	....	44·3	....

Cities and Towns in the Province of Alberta—Daily record of water consumption in Imperial gallons for the year 1920.—Continued.

Month	Edmonton						Lethbridge					
	Population 60,000						Population 12,000					
	Daily Average for the Month	Per Head for domestic purposes	Per Head for industrial purposes	Per Head for other purposes	Per Head for all purposes	Unaccounted for	Daily Average for the Month	Per Head for domestic purposes	Per Head for industrial purposes	Per Head for other purposes	Per Head for all purposes	Unaccounted for
January	6,485,258	55·9	24·8	19·0	99·7	....	1,558,451	87·3	39·5	....	126·8	....
February	6,337,655	55·9	24·4	17·1	97·4	....	1,431,682	78·6	37·3	....	115·9	....
March	6,306,806	55·1	23·3	17·6	96·0	....	1,486,709	81·9	38·3	....	120·2	....
April	6,227,566	54·8	24·6	16·3	95·7	....	1,397,566	80·6	32·9	....	113·5	....
May	5,848,419	52·6	22·3	14·5	89·4	....	1,380,806	77·3	34·5	....	111·8	....
June	6,949,933	53·8	23·1	14·6	91·5	....	1,499,966	117·6	31·2	3·8	152·6	....
July	6,298,741	55·9	23·5	17·3	96·7	....	1,820,161	101·8	32·5	12·2	146·5	....
August	6,179,032	55·4	23·3	16·4	95·1	....	1,958,483	113·0	36·2	8·2	157·4	....
September	6,026,866	54·7	23·1	14·8	92·6	....	1,668,900	103·0	32·1	3·2	138·3	....
October	5,959,644	54·5	22·3	14·3	91·1	....	1,523,096	85·0	38·4	....	123·4	....
November	5,990,866	54·6	23·1	14·5	92·2	....	1,552,366	90·8	35·2	....	126·0	....
December	6,167,355	53·1	23·5	18·2	94·8	....	1,451,258	85·0	32·5	....	117·5	....
Av. for year	6,231,511	54·7	23·4	16·2	94·3	....	1,560,787	91·8	35·1	*6·8	129·1	....

*For 4 months.

Month	Medicine Hat						Redcliff					
	Population 11,000						Population 2,200					
	Daily Average for the Month	Per Head for domestic purposes	Per Head for industrial purposes	Per Head for other purposes	Per Head for all purposes	Unaccounted for	Daily Average for the Month	Per Head for domestic purposes	Per Head for industrial purposes	Per Head for other purposes	Per Head for all purposes	Unaccounted for
January	2,266,451	....	....	....	206·4	....	219,887	86·1	14·7	....	100·8	....
February	2,135,172	....	....	....	194·1	....	207,483	82·2	13·1	....	95·3	....
March	2,063,226	....	....	....	189·3	....	202,306	80·7	11·1	....	91·8	....
April	1,928,333	....	....	....	177·1	....	182,387	74·2	12·8	....	87·0	....
May	2,240,968	....	....	....	203·7	....	152,564	55·3	15·4	....	70·7	....
June	2,621,667	....	....	....	238·3	....	175,734	59·6	23·8	....	83·4	....
July	2,822,903	....	....	....	256·6	....	234,637	83·0	24·7	....	107·7	....
August	3,012,258	....	....	....	273·5	....	255,024	102·0	14·9	....	116·9	....
September	2,391,333	....	....	....	217·4	....	185,991	70·4	14·8	....	85·2	....
October	2,039,667	....	....	....	185·4	....	141,580	42·6	22·4	....	65·0	....
November	1,812,333	....	....	....	165·6	....	126,250	42·1	17·1	....	59·2	....
December	1,911,290	....	....	....	174·6	....	104,145	37·7	10·1	....	47·8	....
Av. for year	2,270,466	....	....	....	206·8	....	182,332	67·9	16·2	....	84·2	....

Cities and Towns in the Province of Saskatchewan—Daily record of water consumption in Imperial gallons for the year 1920.

Month	Regina						Saskatoon					
	Population 40,000						Population 28,000					
	Daily Average for the Month	Per Head for domestic purposes	Per Head for industrial purposes	Per Head for other purposes	Per Head for all purposes	Unaccounted for	Daily Average for the Month	Per Head for domestic purposes	Per Head for industrial purposes	Per Head for other purposes	Per Head for all purposes	Unaccounted for
January	2,376,761	48·6	10·7	....	59·3	....	1,848,064	26·7	1·1	19·6	64·0	16·6
February	2,353,149	47·3	10·7	....	58·0	....	1,844,827	26·7	1·1	19·6	64·0	16·6
March	2,281,600	48·2	8·7	0·1	57·0	....	1,941,290	26·7	1·1	19·6	64·0	16·6
April	2,057,879	43·7	6·7	0·2	50·6	....	1,960,000	27·2	21·1	1·6	73·8	23·9
May	1,988,064	45·5	4·0	0·1	49·6	....	2,027,471	27·2	21·1	1·6	73·8	23·9
June	2,114,955	48·9	3·8	0·2	52·9	....	2,365,733	27·2	21·1	1·6	73·8	23·9
July	2,385,828	51·5	8·1	0·3	59·9	....	2,535,806	35·2	16·0	1·7	85·0	32·1
August	2,508,756	52·7	8·7	0·2	61·6	....	2,398,774	35·2	16·0	1·7	85·0	32·1
September	2,559,921	48·5	12·3	2·7	63·5	....	2,294,666	35·2	16·0	1·7	85·0	32·1
October	2,668,673	50·5	13·6	2·4	66·5	....	2,230,322	28·2	19·2	1·3	73·6	24·9
November	2,607,497	50·5	11·2	2·9	64·6	....	2,070.533	28·2	19·2	1·3	73·6	24·9
December	2,542,114	51·0	10·3	2·2	63·5	....	2,041,741	28·2	19·2	1·3	73·6	24·9
Av. for year	2,332,933	48·9	9·1	*0·9	58·8	....	2,129,852	29·4	14·3	6·1	74·1	24·4

*For 10 months.

Month	Moosejaw						North Battleford					
	Population 23,000						Population 4,000					
	Daily Average for the Month	Per Head for domestic purposes	Per Head for industrial purposes	Per Head for other purposes	Per Head for all purposes	Unaccounted for	Daily Average for the Month	Per Head for domestic purposes	Per Head for industrial purposes	Per Head for other purposes	Per Head for all purposes	Unaccounted for
January	762,000	20·4	12·7	....	33·1	....	197,258	11·4	5·8	3·3	41·8	21·3
February	747,000	20·4	12·0	....	32·4	....	196,800	13·5	0·9	12·7	38·1	11·0
March	801,000	23·2	11·6	....	34·8	....	164,513	11·3	0·8	17·5	34·9	5·3
April	820,000	23·4	12·3	....	35·7	....	201,706	12·5	0·9	6·5	42·7	22·8
May	846,000	26·3	10·5	....	36·8	....	141,135	11·4	3·9	3·7	27·9	8·9
June	909,000	27·3	12·2	....	39·5	....	121,500	10·9	6·2	3·3	25·9	5·5
July	991,000	26·7	16·4	....	43·1	....	156,200	11·7	4·6	2·1	33·1	14·7
August	1,117,000	21·8	26·7	....	48·5	....	149·064	11·5	0·6	6·2	28·4	10·1
September	1,008,000	24·6	19·2	....	43·8	....	164,363	10·5	3·7	3·9	34·5	16·4
October	970,000	25·8	16·3	....	42·1	....	135,058	9·0	7·4	3·8	27·5	7·3
November	958,000	27·2	14·4	....	41·6	....	116,180	11·9	17·6	4·2	39·3	5·6
December	852,000	26·9	10·4	....	37·3	....	165,651	10·3	17·1	4·1	34·0	2·5
Av. for year	898,417	24·5	14·5	....	39·1	....	159,119	11·3	5·8	5·9	34·0	10·9

Month	Weyburn						Estevan					
	Population 4,000											
	Daily Average for the Month	Per Head for domestic purposes	Per Head for industrial purposes	Per Head for other purposes	Per Head for all purposes	Unaccounted for	Daily Average for the Month	Per Head for domestic purposes	Per Head for industrial purposes	Per Head for other purposes	Per Head for all purposes	Unaccounted for
January	102,466	25·6	....	....	25·6	....	33,322	8·2	2·9	....	11·1	....
February	139,344	44·8	....	....	44·8	....	32,827	7·8	3·0	....	10·8	....
March	115,186	28·8	....	....	28·8	....	29,709	6·9	2·9	....	9·8	....
April	101,491	25·3	....	....	25·3	....	33,600	6·1	5·1	....	11·2	....
May	100,737	25·1	....	....	25·1	....	38,000	7·7	4·9	....	12·6	....
June	116,066	29·0	....	....	29·0	....	41,466	8·5	5·1	....	13·6	....
July	112,578	28·2	....	....	28·2	....	55,484	11·2	7·3	....	18·5	....
August	129,906	32·6	....	....	32·6	....	60,516	12·8	7·3	....	20·1	....
September	123,254	30·8	....	....	30·8	....	51,066	9·4	7·5	....	16·9	....
October	123,720	30·9	....	....	30·9	....	42,870	12·0	2·2	....	14·2	....
November	119,791	29·9	....	....	29·9	....	37,600	10·1	2·3	....	12·4	....
December	121,076	30·2	....	....	30·2	....	38,419	10·5	2·2	....	12·7	....
Av. for year	117,301	30·2	....	....	30·2	....	41,239	9·3	4·4	....	13·7	....

Cities and Towns in the Province of Saskatchewan—Daily record of water consumption in Imperial gallons for the year 1920.—Continued.

Month	Kindersley						Kamsack					
	Daily Average for the Month	Per Head for domestic purposes	Per Head for industrial purposes	Per Head for other purposes	Per Head for all purposes	Unaccounted for	Daily Average for the Month	Per Head for domestic purposes	Per Head for industrial purposes	Per Head for other purposes	Per Head for all purposes	Unaccounted for
January.....	9,571	5·8	3·1	....	8·9	....	271,096	7·2	143·3	....	150·5	....
February...	7,311	5·0	3·0	....	8·0	....	258,482	9·5	134·1	....	143·6	....
March......	9,097	7·5	....	....	7·5	....	253,000	4·9	134·4	1·8	141·1	....
April.......	8,737	7·3	....	....	7·3	....	228,000	4·4	120·3	0·2	124·9	....
May........	22,073	7·0	12·2	....	19·2	....	210,551	4·3	112·6	....	116·9	....
June........	32,578	7·4	25·2	....	32·6	....	222,966	7·2	116·6	....	123·8	....
July........	40,066	6·5	32·3	....	38·8	....	292,225	4·9	139·5	....	144·4	....
August......	44,730	8·1	35·1	....	43·2	....	....	....	....	....	....	....
September..	39,953	7·6	28·1	....	35·7	....	....	....	....	....	....	....
October....	24,917	6·9	9·4	....	16·3	....	....	....	....	....	....	....
November..	24,019	7·3	10·4	....	17·7	....	....	....	....	....	....	....
December..	30,548	7·0	16·2	....	23·2	....	....	....	....	....	....	....
Av. for year	24,466	6·9	*17·5	....	21·5	....	....	....	....	....	....	....

*For 10 months.

Cities and Towns in the Province of Alberta—Record of average daily water consumption in Imperial gallons for years 1915-16-17-18-19-20.

Year.	Per Head Domestic	Per Head Industrial.	Per Head Other Purposes.	Per Head All Purposes	Unaccounted for	Per Head Domestic	Per Head Industrial	Per Head Other Purposes	Per Head All Purposes	Unaccounted for	Per Head Domestic	Per Head Industrial	Per Head Other Purposes	Per Head All Purposes	Unaccounted for	Per Head Domestic	Per Head Industrial	Per Head Other Purposes	Per Head All Purposes	Unaccounted for
	Edmonton					Lethbridge					Medicine Hat					Redcliff				
1915	46·0	31·0	3·0	80·0	.....	81·4	32·2	1·5	115·1	.....	181·0	28·0	15·0	224·0	.....	31·1	6·8	.....	37·9	.....
1916	52·5	20·7	5·7	78·9	.....	116·0	41·3	0·7	158·0	.....	214·0	.....	.....	214·0	.....	36·8	22·1	1·0	59·9	.....
1917	56·3	25·0	9·7	91·0	.....	95·0	55·0	.....	150·0	.....	257·0	.....	.....	257·0	.....	42·5	30·3	.....	72·8	.....
1918	58·0	26·2	10·1	94·3	.....	102·2	44·7	3·0	149·9	.....	.....	.....	.....	264·0	.....	66·4	22·4	.....	88·8	.....
1919	56.7	24·6	9·7	91·7	.....	78·1	26·9	.....	107·3	.....	.....	.....	.....	234·0	.....	79·1	13·7	.....	92·8	.....
1920	54·7	23·4	16·2	94·3	.....	91·8	35·1	°6·8	129·1	.....	.....	.....	.....	206·8	.....	67·9	16·2	.....	84·2	.....
	Bassano					Carmangay					Athabaska									
1915	6·5	60·2	.....	66·7	.....	41·9	.....	2·0	43·9	.....	14·3	.....	.....	14·3	.....	.....	.....	.....	.....	.....
1916	.....	.....	.....	.....	.....	32·6	.....	.....	32·6	.....	10·9	.....	.....	10·9	.....	.....	.....	.....	.....	.....
1917	17·9	154·3	95·4	267·6	.....	31·3	.....	.....	31·3	.....	24·0	.....	.....	24.0	.....	.....	.....	.....	.....	.....
1918	.....	.....	.....	211·0	.....	29·8	.....	1·0	30·8	.....	27·6	.....	.....	27·6	.....	.....	.....	.....	.....	.....
1919	.....	.....	.....	194·7	.....	32·5	.....	1·2	33·7	.....	26·1	.....	.....	26·1	.....	.....	.....	.....	.....	.....
1920	.....	.....	.....	158·9	.....	26·2	.....	*3·4	30·3	.....	44·3	.....	.....	44·3	.....	.....	.....	.....	.....	.....

°4 months. *7 months.

Cities and Towns in the Province of Saskatchewan—Record of average daily water consumption in Imperial gallons for years 1915-16-17-18-19-20.

	Regina					Saskatoon					Moosejaw					North Battleford				
1915	55·0	7·5	0·1	62·6	.....	21·6	13·9	2·2	45·6	7·9	24·1	4·6	.....	28·7	.....	6·6	1·3	2·7	14·8	4·2
1916	66·1	7·8	.....	68·9	.....	21·0	15·4	1·9	52·6	14·3	35·2	12·3	.....	47·5	.....	9·5	2·0	4·9	22·7	6·3
1917	59·2	12·6	0·3	72·1	.....	24·4	15·6	5·8	66·4	20·6	45·8	13·1	.....	58·9	.....	10·2	2·2	4·0	23·1	6·7
1918	56·9	11·1	0·1	68·1	.....	27·1	17·2	2·4	63·1	16·4	31·6	15·4	.....	47·0	.....	10·0	4·8	3·0	26·3	8·5
1919	42·8	8·3	.....	51·2	.....	28·0	16·3	1·9	64·1	17·9	24·8	15·1	.....	39·9	.....	11·5	1·6	4·4	29·7	12·2
1920	48·9	9·1	*0·9	58·8	.....	29·4	14·3	6·1	74·1	24·4	24·5	14·5	.....	39·1	.....	11·3	5·8	5·9	34·0	10·9
	Weyburn					Estevan					Kamsack					Kindersley				
1915	17·4	.....	0·4	17·8	.....	9·5	7·1	1·5	18·1	.....	.....	.....	.....	.....	.....	4·9	8·4	1·6	14·9	.....
1916	16·9	.....	0·3	17·2	.....	8·2	5·7	1·0	14·9	.....	.....	.....	.....	.....	.....	5·5	26·8	.....	32·3	.....
1917	30·1	.....	.....	30·1	.....	9·7	5·5	4·3	19·5	.....	.....	.....	.....	.....	.....	5·8	44·4	.....	50·2	.....
1918	26·4	.....	.....	26·4	.....	9·3	0·7	7·2	17·2	.....	31·6	66·3	.....	97·9	.....	6·0	8·9	.....	14·9	.....
1919	25·5	.....	.....	25·5	.....	9·6	2·9	.....	12·5	.....	.....	.....	.....	.....	.....	7·8	.....	.....	7·8	.....
1920	30·2	.....	.....	30·2	.....	9·3	4·4	.....	13·6	.....	.....	.....	.....	.....	.....	6·9	*17·5	.....	21·5	.....

*For 10 months.

ARTESIAN WELLS

There has been no opportunity during the past year for gaining any additional information regarding artesian wells.

STOCK-WATERING RESERVES

A comparatively small number of these reserves has been examined during the past season owing to pressure of other work, and in most cases maintenance of the reserve has been recommended with a view to a better water supply for the settlers in the district or in connection with stock sanctuaries.

CYPRESS HILLS DISTRICT, SOUTHEAST

Mr. M. H. French was again in charge of this district. He took the field on May 5 and completed his field-work on December 7. The season's work comprised 180 actual working days. One hundred and twenty-one inspections, forty surveys and thirty-four stream gaugings were made. Data were gathered concerning thirty-one wells and six domestic water supplies. The number of miles travelled by train were 1,059, by motor-car and other means 6,696.

Mr. French made a reconnaissance survey early in the season of the lands lying within the Frenchman River and Battle Creek valleys in order to determine the approximate areas susceptible of irrigation from the proposed Cypress Lake reservoir. This reconnaissance work determined the location and extent of field-work required for a more accurate survey of the proposed project to permit of an estimation of the areas that could be benefited. Based on the information thus obtained a party under Mr. W. Wotherspoon was assigned to the further development of the project and the necessary surveys were completed on the 30th October.

After an inspection of the proposed main canal and distributaries projected by Mr. Wotherspoon's party near Vidora, Saskatchewan, it was decided to make a general study of alkali conditions so as to be in a position to determine whether the farmers in the vicinity affected by the proposed project would be justified in proceeding with the erection of an irrigation district. Unfortunately, however, pressure of other work prevented a detailed study of these conditions being made. The three weeks' work which was devoted to soil tests proved that the higher lands were comparatively free of alkali to a depth of eighteen inches and rather seriously impregnated below that depth. The low lying lands, however, contain an excessive amount of alkali—even nearer the surface. The whole question, therefore, requires further careful investigation before any definite steps are taken toward the organization of an irrigation district, or districts, or the construction of works for the irrigation of these areas. This proposed project is more fully dealt with in a subsequent portion of this report.

Extracts covering the salient features of Mr. French's report on the East Cypress Hills District are given in the following paragraphs:—

" The general inspection work was interrupted for about one week, commencing July 20, when the failing water supply of Battle creek necessitated the presence of a water master to regulate the ditch diversions in order to prevent trouble between the irrigators, and to protect riparian rights along the creek. This visit was made at the critical period of flow and proved conclusively the necessity of proper regulation of the water at the lower stages of flow. Had the headgates not been closed promptly, there would have been a shortage of water in Battle creek near Consul such as occurred in the season of 1919, with its attendant troubles.

No construction or development of any note can be reported for the year 1920. The remarks made in my 1919 annual report regarding the condition of works

and development of irrigation in the several stream basins radiating from the Cypress hills, are still applicable for 1920. Since writing the previous report it has become definitely known that there is no immediate prospect of the erection of an irrigation district at East End. The success or failure of irrigation by pumping will have to be definitely proven in that vicinity before the people will consent to incur the heavy obligations attending the creation of a district. In the Battle Creek valley the seeming indifference of the people toward irrigation and the high cost of the proposed Cypress Lake reservoir scheme preclude any hope of immediate action in the vicinity of Vidora. In the other valleys the interest taken in irrigation has apparently subsided somewhat during the past year."

CYPRESS HILLS DISTRICT, SOUTHWEST

Mr. C. M. Moore was placed in charge of this district and commenced his duties May 27. During the first three weeks of this month and for the greater portion of the month of August Mr. Moore was engaged on survey and investigation work in the Sevenpersons drainage basin. Field-work was carried on until November 17, when owing to the continued cold weather a return to the Calgary office became necessary. The season's work comprised 167 working days. Ninety-five inspections and fifty-eight surveys were made. Information concerning fourteen domestic water-supply schemes and fifty-three wells was obtained. The number of miles travelled by train was 270, by car, 5,700. Extracts covering the salient points in Mr. Moore's report are given in the following paragraphs:—

"The irrigation practised during the 1920 season was limited, owing to works being out of repair, or to negligence. The works on many schemes were out of order owing to the prohibitive cost of labour and materials. The negligence appeared to be due to the fact that certain licensees, owing to an adequate early spring rainfall, anticipated the continuance of these conditions and failed to repair their works. Some licensees were so busy with seeding operations, on account of spring being a month later than usual, that there was no water available in the streams when they were ready to apply it.

"Among those who practised irrigation most successfully last season were Messrs. E. F. Harms and C. A. Wiley. The former grew eight hundred tons of blue joint hay from spring flooding only, the latter also obtained good yields of grain from spring flooding.

"Very few new schemes were completed this season because of the scarcity of labour and high price of materials. In the vicinity of the successfully operated schemes the farmers who are convinced of the value of irrigation are very anxious to obtain water rights and many have submitted memorials. In some of these cases the only way in which they can be assured of sufficient water is for the applicants to form an irrigation district and store all the water available. No doubt the present licensees on such streams would allow their licenses to be reduced for the privilege of using stored water during July or August, when it would be more beneficial than when applied in April and May, which is usually the only time they can now get it.

"In the higher altitudes of the Cypress hills, above 3,000 feet, there was a fair amount of rainfall during the growing season. Below this elevation the grain did well until the first week in July when the absence of moisture caused it to wilt, from which state it never revived. In small scattered areas on the lower altitudes the wheat yielded eight bushels per acre while on the greater areas it yielded an average of three bushels to the acre."

CALGARY AND CARDSTON DISTRICTS

These districts were administered by Mr. R. H. Goodchild, who took the field on May 17 and finished the season's field-work on December 11. The season's work

comprised 168 actual working days. Sixty-seven inspections, thirty-five surveys, seven stream gaugings and forty-two miles of traverse were made. The number of miles travelled by train was 335, by motor car, 4,790. Mr. Goodchild was assisted by one helper and had the use of a Ford touring car for transportation purposes throughout the season.

The territory covered by Mr. Goodchild included all the Foothills country south of Calgary; it is devoted largely to stock raising, and the land which is cultivated is used almost exclusively for the growing of fodder crops.

A succession of dry years has thoroughly convinced the farmers of the whole of southern Alberta of the wisdom of using and conserving, where possible, all the available water.

Mr. Goodchild points out in his report that a large proportion of the people is convinced that irrigation is their only hope of being able to make a living, and, as a consequence, the slogan has been taken up, "Irrigate or Emigrate." This appreciation of the need for irrigation has led to a great increase in the number of applications which have been received, and the supply in some of the streams in this district is fast being appropriated.

An interesting feature in Mr. Goodchild's report is the effect of irrigation on cutworms. A farmer, whose field was observed to be suffering badly from this pest asked for assistance in the location of his lateral ditches in order to enable him to irrigate the area affected. The ditches were duly laid out and rapidly constructed and water applied within a very few days. As soon as the water reached the affected portions the work of destruction was arrested, and finally stopped. The whole field was irrigated and no further trouble experienced. Except in cases where the roots had been destroyed before the water was applied this crop was thick and heavy and the yield was high. Whether the cutworms were actually killed cannot be stated, but it was made manifest that the application of water to the land while the cutworms were very active, rendered these pests harmless.

SPECIAL INSPECTIONS—ALBERTA DISTRICT

This work was carried out by Mr. F. R. Burfield, who took the field on May 27, and finished the season's field-work on December 22. This comprised 196 actual working days; sixty inspections and thirty-six surveys were made. The number of miles travelled by train was 3,237 and by other means, 2,279.

The following impressions which have been set forth in Mr. Burfield's report are of interest and are quoted in the following paragraphs:—

"It may be interesting to note the changes which have come over inspection work since I was engaged on it in 1913-14-15; probably my four years' absence overseas causes the changes to strike me more forcibly than they do those who have been in continuous touch with the work.

"The most noteworthy and striking change is the difference in feeling which has become general throughout the country as a result of the successive dry years. In 1915 very little interest was taken in irrigation, and it was generally looked on as somewhat of a fad. I believe the majority of people considered the money spent by the government in research and administrative work was wasted. To-day irrigation is a live question and has few, if any, detractors. Another change is the very much greater capital cost which an irrigation scheme is considered able to bear an instance of this is the large increase in the number of pumping schemes projected. Another point of difference is in the financial position of the men who are applying for irrigation rights. Five or more years ago the majority of these men were ranchers with considerable means; in most cases they were combining land purchase at a cheap rate with their irrigation schemes, which were usually inexpensive. The result of

this was that after paying the purchase price of the land and the cost of the irrigation works, they could have sold the land at a profit without asking anything for the value conferred upon it by the irrigation works. The present type of applicant is usually one who has bought his land at the prevailing market rate, and is still trying to pay for it, or who has taken it up as a homestead, and is in debt for his machinery, stock, etc. The result of this is that the irrigator of to-day is financially less able to put in permanent works than the applicant of five or ten years ago; he shows promise, however, of ultimately becoming a more successful irrigator."

CANADIAN PACIFIC RAILWAY COMPANY'S IRRIGATION PROJECTS

Western Section.—The Canadian Pacific Railway Company has disposed of nearly all the land in this section and the larger part of the area is under cultivation. Grain and flax were practically the only crops grown this year.

During the early summer there was a good rainfall and crops gave promise of a large yield, but owing to drought later they produced somewhat less than was estimated. Had they been irrigated during the dry spell they probably would have produced the estimated yield.

Only about 4,000 acres were irrigated in this section this season, as compared with 31,908 acres in 1919, out of a total irrigable area of some 221,000 acres.

In accordance with the general policy followed by the company for several years, of replacing the original structures with a more permanent type, a number of the larger wooden structures have been rebuilt with concrete.

Eastern Section.—Settlement of this area is proceeding rapidly. No extensions or new construction have taken place this year, but owing to the fact that a large part of the system has been constructed for eight or nine years and colonization was held up during the war, it has been necessary to do considerable repairing and enlarging of the laterals this year to keep pace with the rapid settlement.

The classification of three large blocks of land in this section has been held up by this office pending further information in regard to soil conditions and drainage. Two of these blocks, comprising about 36,000 acres of irrigable land, have now been released. This is the area northeast of Brooks under the North Bantry canal, and the St. Julien Colony located south of Tilley. The third block includes all the land served by the Rolling Hills canal. The classification of this area is still being held in abeyance pending a decision of the company in regard to drainage.

During the season of 1920 there were about 60,700 acres irrigated in this section as against 43,400 the year before. The total area irrigable is about 400,000 acres.

Lethbridge Section.—After eighteen years of successful operation, this continues to be the best argument in the province in favour of irrigation. It is reported that the average value of the crops raised during 1920 on the 80,000 acres under crop included in this scheme was $49.31 per acre. The amount of land actually irrigated during 1920 fell off about fifteen per cent from last year, water being delivered to 60,000 acres. This was due to the climatic conditions being somewhat more favourable for raising dry crops than in the previous three years.

The programme for improvement of this system which the company has carried out during the last two years was continued during this year. The enlargement of Chin Lateral No. 1 was nearly completed and Chin reservoir was filled to capacity last fall through this canal. The old headgates and spillway at the lower end of Nine-mile coulee, by which waste water was discharged into Etzikom coulee, have been abandoned, and the Six-mile coulee spillway constructed to take their place. This wasteway takes off the main canal near Chin headgates and consists of a con-

structed channel with several drops running to the head of Six-mile coulee. The new concrete dam and headgates at Magrath which replace the old timber structure and which were started in 1919 were completed during this season and are now in operation. A considerable portion of the main canal below Pothole coulee, in the vicinity of Magrath, was enlarged and the banks on the lower side were strengthened. A number of aditional timber checks were built in the natural channels to further control erosion.

This system differs from the Eastern and Western sections which were constructed later, in that the farmers own the smaller laterals which supply them from the company's main distributaries. They have recently awakened to the fact that in order to operate these successfully they must have an organization and have formed, within the last two years, four water users' districts under the Irrigation Districts Act of Alberta.

TABER IRRIGATION DISTRICT

This district was the first to organize under the Irrigation Districts Act of Alberta, having been erected in 1915. After considerable delay they finally entered into a contract with the Canadian Pacific Railway Company in the spring of 1919 to take their bonds and construct the necessary works. The district owns, operates and maintains the system, and the company delivers water to their headgates through the Lethbridge Section canals and the Chin Coulee reservoir.

The construction of the irrigation works for the supply of this district was completed in October, 1920, and water was turned into the system. The ditches were thoroughly primed and about 2,000 acres were fall-irrigated.

It was expected that water could be delivered to the district by July 1, 1920, but the unusually heavy winds in the spring blew the ditches full of sand and this, together with the difficulty of obtaining sufficient help during the summer, delayed completion until late fall.

The Canadian Pacific Railway Company improved their reservoir facilities in Chin coulee this year by constructing an additional outlet of 48-inch cast-iron pipe at the Stafford reservoir and by raising the dam of the Chin Butte reservoir about seven feet to the full height proposed.

The works have now been officially turned over to the district, and it is expected that the larger part of the 17,000 acres under the system will be irrigated this coming season.

SOUTH SASKATCHEWAN DIVERSION PROJECT

A brief history of this project was published in the last annual report.

The Saskatchewan Water Supply Commission, which was appointed by the Provincial Government in 1920, has now published its report from which the following is compiled:—

It is proposed to divert from the South Saskatchewan river by pumping at a point about three miles above Elbow, Saskatchewan, an average of about 12,000,000 Imperial gallons per day with a maximum of 16,000,000 per day during the short time of excessive consumption each year. This is equal to a diversion rate of about twenty-three to thirty cubic feet per sceond.

The water is to be distributed through concrete, wood-stave and steel-pipe lines for domestic and municipal purposes to a district covering some 1,620 square miles, in which there are resident about 85,200 people. About three-quarters of this population, however, is in the cities of Moosejaw and Regina. The balance is distributed among some thirty-four towns and villages and other rural communities within this area. It is estimated that water can be delivered to consumers at a rate not to exceed one dollar per thousand gallons.

The cost of construction is to be met by the sale of debentures secured by the total assessable property within the district.

It is the purpose of the commission to submit the matter to a vote of the district during the coming summer. Mr. A. J. McPherson of Regina is the chairman of the commission.

SEVENPERSONS DRAINAGE BASIN

Investigation.—This work was begun late in the fall of 1919 and has been continued during 1920 with the result that two irrigation districts have been organized in this basin under the Irrigation Districts Act of the province of Alberta, known as the Medicine Hat Southern and Medicine Hat Eastern Districts.

The Southern project extends from the town of Sevenpersons on the Lethbridge-Crowsnest section of the Canadian Pacific railway northeasterly along the line of the railway nearly to the southern limits of the city of Medicine Hat. The Eastern Project adjoins the Southern on the north and includes the land between it and the southern limits of the city and extending easterly between the railroad and Ross creek to a point about five miles east of the city. The proximity of this land to the city of Medicine Hat affords a ready market, and the fact that the Canadian Pacific railway traverses the tract for almost its entire length, giving easy access to transportation, makes these projects particularly attractive.

Water Supply.—The water supply for these projects is taken from two streams, Ross creek and Sevenpersons creek, which rise in the Cypress hills and flow into the South Saskatchewan at the same point within the limits of the city of Medicine Hat. The records of the discharge of these streams extend over a period from 1913 to date in the case of Sevenpersons creek, and 1911 to date in the case of Ross creek. The observations on Sevenpersons creek have been taken at Medicine Hat; those for Ross creek at Irvine, about eighteen miles east of the city. The duration of flow in both streams is quite similar. The larger part of the run-off comes during March and April. In exceptional years it may begin in February or extend into June, but usually it has practically stopped by the first of May. This makes it imperative, in order to irrigate any large areas after the first of May, to have some means of storing the water for use later in the season. Reservoirs have, therefore, been provided for this purpose in connection with both these projects.

A detailed study of the water supply for these two projects shows that if they had been in existence during the period over which records were taken there would have been water sufficient to give the irrigations shown in the following table:

Medicine Hat Southern District (Sevenpersons Creek)				Medicine Hat Eastern District (Ross Creek)			
Year	Depth Irrigation	Rainfall	Total Water Rec'd	Year	Depth Irrigation	Rainfall	Total Water Rec'd
	Inches	Inches	Inches		Inches	Inches	Inches
1911	....	....	....	1911	10	10·0	20·0
1912	....	....	....	1912	17	6·7	23·7
1913	10·0	6·7	16·7	1913	12	6·7	18·7
1914	3·0	3·5	6·5	1914	6	3·5	9·5
1915	12·0	11·2	23·2	1915	18	11·2	29·2
1916	18·0	12·6	30·6	1916	18	12·6	30·6
1917	18·0	3·3	21·3	1917	18	3·3	21·3
1918	18·0	5·0	23·0	1918	17	5·0	22·0
1919	12·0	2·9	14·9	1919	4	2·9	6·9
1920	13·5	5·0	18·5	1920	14	5·0	18·5

The table shown above is based on an irrigation factor of eighty-three per cent in the case of the Eastern project and one hundred per cent in the case of the Southern project.

It should be noted that neither of these projects will be able to get the full duty of water (eighteen inches) every year. While the government experiments in the duty of water indicate that to produce during the dryer seasons the maximum yield of those crops which require the largest amount of water it is necessary to apply during the season a quantity of water equal to eighteen inches in depth over the irrigated area, it does not necessarily follow that the application of a lesser quantity will not produce a profitable crop.

On account of the bulk of the water running into the reservoirs in the early spring it will be possible about the first of May each year to forecast the quantity available for irrigation during the season. This makes it possible in years of shortage, like 1914 and 1919, to deliver double the quantity to half the area on each individual holding, thereby ensuring a good crop on half of the land instead of practically no crop or a very poor one on the whole area.

MEDICINE HAT SOUTHERN DISTRICT

Works.—The irrigation system designed for this district contemplates the construction of an earth dam on Sevenpersons creek in section 18, township 10, range 7, west of the 4th, which will create a reservoir of 24,506 acre-feet capacity, called the Sevenpersons Reservoir No. 2. The water coming down in the spring will be caught in this basin and kept for irrigation later in the season. About half a mile below this on the stream will be located another dam and the headgates for the purpose of diverting the water, which is turned out of the reservoir into the main canals. These are to be constructed one on each side of the creek.

East Ditch.—About three and one-half miles from the headgate the easterly canal crosses Paradise creek, a tributary to Sevenpersons creek. A small pile and crib overflow dam will be located here to divert the water of this creek into the system. The canal from this point to the Auxiliary Reservoir No. 2, about three miles farther on, will be of an enlarged section sufficient to carry these flood waters to the reservoir where they will be stored. The capacity of this reservoir is 900 acre-feet. The canal continues from this point in a northeasterly direction and ends in section 32, township 11, range 5, west of the 4th meridian.

West Ditch.—The westerly ditch runs in a northeasterly direction along the west side of Sevenpersons creek for about nine miles to Auxiliary Reservoir No. 1, located in sections 15 and 22, township 11, range 7. The capacity of this reservoir is 600 acre-feet. It will be filled from the waters of Sevenpersons creek. The canal continues from this point in a northeasterly direction covering the lands to the east of the city and terminating in section 31, township 12, range 6.

There is included in this district 134 quarter-sections. Six of these are cut by the main canals and contain 170 acres to which water will be delivered. The remaining 128 quarters will have water supplied for forty acres only in each quarter-section.

It is anticipated that when the proposed Lethbridge Southeast project is completed and in operation there will be a considerable amount of waste water draining into Chin and Forty-mile coulees. An investigation has shown that by constructing small ditches between the natural ponds in these coulees this water can be run to a depression at their junction where it would form a natural lake. By cutting through the height of land between this lake and Sevenpersons creek this water could be made available for the "Southern project." It would involve a long, deep cut, however, which would not be warranted at present; it was considered advisable to design the

system so that the irrigable land commanded was much in excess of that for which water is at present available, so that when the additional water supply is developed the boundaries of the district will not have to be enlarged but the irrigable area within the district may be increased.

SUMMARY OF WORKS

Sevenpersons Reservoir No. 2—		
Capacity	ac.-ft.	24,506
Full supply level elevation	"	2,517.5
Outlet elevation	"	2,486.0
Crest of dam elevation	"	2,524.0
Maximum height of dam	ft.	39
Auxiliary Reservoir No. 1—		
Capacity	ac.-ft.	600
Auxiliary Reservoir No. 2—		
Capacity	ac.-ft.	900
Total storage capacity on project	ac.-ft.	26,006
Total land to be irrigated	acres	5,300

SUMMARY OF ESTIMATED COST

Sevenpersons Reservoir No. 2	$ 36,790
Diversion Dam and Headgates	6,960
Auxiliary Reservoir No. 1	5,600
Auxiliary Reservoir No. 2 and Dam on Paradise Creek	14,700
East Ditch and Laterals	36,690
West Ditch and Laterals	37,700
	$138,440
Contingencies and Engineering, 15 per cent	20,766
	$159,206
Right of Way	73,075
	$232,281
Two years' interest at 6 per cent	31,674
Total cost of project	$263,955

On the basis of 5,300 acres irrigable—$49.80 per acre.

The order erecting this district was published in the *Alberta Gazette* of January 31, 1921. The trustees are J. F. Leonard, John Reynolds and J. B. Swan, and the secretary is C. A. Richardson, all of Medicine Hat, Alberta.

MEDICINE HAT EASTERN IRRIGATION DISTRICT

The irrigation system of this district contemplates the construction of two reservoirs for the storage of flood waters, one known as the Ross Creek reservoir, formed by the construction of an earth dam on Ross creek in section 15, township 12, range 4. This reservoir is so located that it will not be possible to use all the water which can be stored, as the level of the outlet ditch is twenty feet above the bottom of the reservoir. This leaves about 2,000 acre-feet of water not available for irrigation. Above this level, however, there will be available a storage capacity of 8,220 acre-feet. The other, known as Gros Ventre reservoir, will be formed by an earth dam on Gros Ventre creek in sections 11 and 14, township 11, range 4. Its capacity will be 5,967 acre-feet, making a total available storage on the project of 14,187 acre-feet. The latter reservoir is about twenty miles above Ross Creek reservoir, and the water stored here will be run down the creek channel as needed to Ross Creek reservoir. From Ross Creek reservoir the water is turned directly into the main canal. The irrigable land begins within three miles of this reservoir, and for the next three miles the canal commands about 1,600 acres lying between it and Ross creek. The water

is then carried across Bullshead Creek valley, a distance of about 4,600 feet, in a 44-inch wood-stave pipe, where it is distributed through canals to about 3,400 acres adjoining the city of Medicine Hat.

SUMMARY OF WORKS

Gros Ventre Reservoir—

Dam site located in sections 11 and 14, township 11, range 4, on Gros Ventre creek.

Capacity	ac.-ft.	5,697
Maximum height of dam	ft.	56
Maximum depth of water	ft.	50

Ross Creek Reservoir—

Dam site located in section 15, township 12, range 4, on Ross creek.

Capacity (available)	ac.-ft.	8,220
Full supply level elevation	ac.-ft.	2,409
Outlet elevation	ac.-ft.	2,386.5
Crest of dam elevation	ac.-ft.	2,406.0
Maximum height of dam	ft.	40

SUMMARY OF ESTIMATED COST

Gros Ventre Reservoir	$ 61,309
Ross Creek Reservoir	72,728
Dyke "C"	4,472
Connection ditch (reservoir to lakes)	10,333
Main canal (lakes to irrigable land)	7,333
C.P.R. crossing "E" end of syphon	624
Syphon	35,069
Wooden structures (entire system)	10,264
Railway crossings	600
Main canal and laterals	14,966
Total	$217,698
Engineering and contingencies, 15 per cent	32,655
Estimated cost actual construction	$250,353
Right of way	19,218
Total	$269,571
Two years' interest at 6 per cent	36,759
Total estimated cost	$306,330

On the basis of 5,000 acres irrigable—$61.27 per acre.

The estimated cost of these projects is based upon 1919 and 1920 prices, and in view of the general decline in prices they can probably be built for much less.

There is some question as to the necessity of providing for 14,187 acre-feet storage, and especially the desirability of constructing Gros Ventre reservoir for this purpose.

To irrigate 4,150 acres net to a depth of fifteen inches during the season, allowing twenty-five per cent loss by absorption in the canals and laterals, requires about 7,000 acre-feet delivered at the headgates of the system, or about 9,100 acre-feet in storage. This latter figure includes 1,200 acre-feet absorption during the irrigation season and 900 acre-feet loss during the winter months from the unavailable portion of the Ross creek storage.

Any capacity in excess of this would be needed to carry over water from the present year only in the years when the run-off was less than this amount, and it would be used when the run-off of the previous year was in excess of this figure.

Taking the records which are available, 1911 to 1920, inclusive, there are six years out of the ten in which excess storage was needed, but owing to the order in which years of low run-off and high run-off happened to come during this period, there were only two years in which this excess capacity would have been used for

storage. It is not fair to assume, however, that the next period of ten years would have the same sequence of low and high run-off, and as the project is one which depends entirely upon storage it is desirable to provide this 5,000 acre-feet excess storage as a safety factor, provided it does not increase the cost of the project beyond a reasonable figure.

To store this water in Ross Creek reservoir, the present proposed level would have to be raised about six feet. Owing to the proximity of the Canadian Pacific railway it is not feasible to raise this water-level higher than at present proposed, but if the grade of the railroad could be raised, and the dyke on that side of the reservoir made part of the grade, it might be possible to store the total amount of 14,187 acre-feet in this reservoir. The cost of this would, however, probably be more than to construct the Gros Ventre reservoir.

It will be noted that the estimated cost per acre of the Medicine Hat Eastern is $61.27 per acre. Assume that it will be $62 per acre. The average value of the crops grown on the Lethbridge section of the Canadian Pacific Railway Company's irrigation project during the season 1920 was $49.31 per acre. Owing to the better climatic conditions on this tract the average per acre should be considerably higher, but we will assume that it is $50 per acre. We are also assuming, however, that only eighty-three per cent of the irrigated land will be irrigated in any one year. We will assume that the seventeen per cent brings in no income. The income from the balance would then be eighty-three per cent of $50-$41.50 per acre. Assuming thirty-year bonds and no contribution to sinking fund for the first five years, there would have to be met every year after the fifth:

Interest at 6 per cent on $62	$3.72
Annual Sinking Fund, 25 years at 4 per cent	1.49
Maintenance and application of water	3.00
	$8.21

Deducting this from the gross income per acre we have left $33.29 per acre. As the average size of the farm under this project is about 100 acres, it would mean that the average farmer would have $3,329 yearly with which to meet the ordinary expenses of the farm and living expenses.

The order erecting this district was published in the *Alberta Gazette* of March 15, 1921.

The Trustees are Henry Cavan of Dunmore, Charles H. Howey and J. B. Swan of Medicine Hat, Alberta. The Secretary is C. A. Richardson of Medicine Hat.

No assurance can at present be given that either the Medicine Hat Southern or the Medicine Hat Eastern projects will be constructed. Unless the Provincial Government approves of the plans and agrees to guarantee the bonds it is unlikely that either will be built in the near future.

CANADA LAND AND IRRIGATION COMPANY

This has been an eventful year for this company. Work was begun on the construction of this system in 1909 and after encountering many difficulties, both financial and constructive, they delivered water to a small acreage for the first time this year (1920).

Water was turned into the canal from Lake McGregor reservoir on April 29, and with the exception of a few days ran continuously throughout the season. Between four and five thousand acres in the Vauxhall district were irrigated, this being all the land which was ready for water this year.

The results from irrigation during 1920 were highly satisfactory on the comparatively small acreage actually watered. A thriving town had sprung up at Vauxhall, several thousand acres of land had been sold and prepared for irrigation in 1921 and

the company expects this year to irrigate not less than 10,000 acres in this district. The work of constructing lateral and distributing ditches is proceeding as rapidly as justified by land sale, while at the same time the main canals and other works are being enlarged, strengthened and improved.

During the summer the chief engineer and manager, Mr. D. W. Hays, under whose able management the work has proceeded to date, resigned and his place has been filled by Mr. F. W. Hanna, formerly of the United States Reclamation Service.

LETHBRIDGE NORTHERN IRRIGATION DISTRICT

Surveys for this project were begun in 1914 and completed in 1916. The annual reports of this branch for 1914, 1915 and 1916 give a detailed account of the work. In 1917 a reservation of water from the Oldman river was made for the benefit of this land.

Application for the formation of this area into an irrigation district under the Irrigation Districts Act of Alberta was made on July 31, 1919, and the order erecting the district was published in the *Alberta Gazette* on October 31, 1919. A corrected notice of erection was published under date of November 29, 1919.

In November, 1919, the trustees appointed Mr. H. B. Muckleston as their chief engineer. The Alberta Government employed Mr. George G. Anderson, a consulting engineer, who submitted a report on the project on January 17, 1920. This was later published in pamphlet form.

Authorization for the construction of works was issued by the Minister of the Interior on March 9, 1920, with the proviso that before the construction of any part of the works was undertaken, complete plans thereof would be filed and approved as required by sections 15 and 16 of the Irrigation Act. Later the district was enlarged to include the area known as the North Macleod project, and the district surrendered this authorization, and a similar one, dated September 8, 1920, was issued.

During the past summer the interest in irrigation was apparently revived in those areas which were originally included in our surveys for the project but in which at the time of organization the sentiment was against inclusion in the Lethbridge Northern Irrigation District. These areas were the Barons-Carmangay, Rocky Coulee and North Macleod areas. The revival of interest resulted, however, in the North Macleod District only petitioning to be included. This makes the total irrigable land in the Lethbridge Northern District 104,758 acres. The order for this enlargement was published in the *Alberta Gazette* of August 14, 1920. The Provincial Legislature during the session of 1921 passed an Act guaranteeing in full the principal and interest on the bonds of the district, amounting to $5,400,000—a sum estimated to be sufficient to cover the entire cost of construction. This Act also provides that the Irrigation Council of the province shall themselves take the necessary steps to let a contract for the construction of the works, and shall exercise general supervision over the trustees in all important matters affecting contracts, construction, etc.

It is understood that the bonds will shortly be offered for sale with this guarantee, which should assure their sale at a good price*. It seems quite probable, therefore, that construction on this project will be commenced this summer.

*Bonds to the amount of $2,400,000 have been sold at a fair price and a contract for the earth-work has been let. Other contracts will be let at an early date and more bonds will be offered for sale as required.

BARONS-CARMANGAY AND ROCKY COULEE DISTRICTS

During the spring of 1920 the Irrigation Council of Alberta investigated the sentiment in these two districts with regard to inclusion in the Lethbridge Northern Irrigation District. It was found that the residents of the Barons-Carmangay area were three to one in favour of inclusion, but unfortunately about fifty per cent of the land

was held by non-residents, only a few of whom replied to the correspondence sent them. The sentiment in the Rocky Coulee District, however, was overwhelmingly in opposition to irrigation. These two projects were therefore not included in the Lethbridge Northern Irrigation District.

SOUTH MACLEOD IRRIGATION PROJECT

In the year 1916, a party in charge of Mr. T. M. Montague located a canal from the Oldman river to command a portion of the area now known as the South Macleod District. It was proposed to use the same intake as the Lethbridge Northern project. The irrigable area was estimated at 9,500 acres in townships 8 and 9, ranges 24, 25 and 26. In 1919 the land owners in townships 6 and 7, ranges 25, 26 and 27, petitioned the Government to include their land, and the necessary surveys were undertaken to determine the feasibility of irrigating this additional area.

Since it was not possible to command the whole of these lands from the Oldman river, other sources of water supply were investigated, such as the possibility of extending the United and Lone Rock system. It was finally decided as the result of a reconnaissance that the most economical development to serve the whole area was to divert water from the Waterton river.

Field Surveys.—A standard twelve-man party in charge of Mr. N. M. Sutherland was assigned to this work and surveys were commenced about the first of June, 1920. The main canals and such of the secondaries as were necessary to determine the commanded area were located by the first of August. Mr. Sutherland's party was then reorganized with a view to completing plane table surveys of the area under the project. On October 1, a second plane table party in charge of Mr. A. B. Cook was transferred to this work and these two parties completed the field surveys on December 7. During the field season the party under Mr. Sutherland completed the following work in 148 working days:—

164 miles of traverse with profile and topography.
116 miles of levels.
51,800 acres of plane-table topography.

Mr. Cook's party completed in 57 working days:—

122 miles of levels.
40,645 acres of plane-table topography.

Soil Surveys.—Mr. P. A. Fetterly made a general survey of the soil of the project, taking fifty-four groups of samples at carefully chosen average points covering the whole district. These samples were tested for alkali with an electrical bridge with the following results:—

36 groups showed no alkali.
9 groups showed moderately strong alkali from 3 to 5 feet.
3 groups showed moderately strong alkali from 1·5 to 5 feet.
5 groups showed moderately strong alkali from 0·5 to 5 feet.
1 group (not completed.)

The land represented by the eight groups of samples showing moderately strong alkali within three feet of the surface was reserved for further investigation during the coming field-season. The district as a whole is considered to be comparatively free from alkali.

The land surface in the southern portion of the district is smooth and fairly uniform but has a heavy slope to the north and east. South and east of Macleod the surface is more rolling and there are numerous depressions which have no natural drainage. In classifying this land a sufficient acreage of the low areas were classed as non-irrigable to contain the drainage from the surrounding irrigable lands. The

soil varies from clay loam to sandy loam and in the northerly sections has a tendency to drift, owing to the prevalence of high winds. In some places the loosened portion of the top soil has entirely blown away, exposing the trails left by the plough when the land was broken. The practice of irrigation, and especially the growing of alfalfa, would obviate the difficulty by supplying sufficient root fibre to hold the soil in place.

Canal Design.—The main and branch canals have been designed for the same maximum requirement as used on the Lethbridge Northern, i.e., of a sufficient size to irrigate fifty per cent of the total area six inches in depth in a period of fifteen days. Seepage losses were estimated at six second-feet per million square feet of wetted area. The total irrigable area is approximately 61,000 acres, which is subject to a slight revision on a more complete soil investigation. A gross main canal capacity of 633 second-feet is required at the intake.

Water Supply.—Assuming an irrigation factor of eighty per cent and an eighteen-inch duty of water, the water requirements are as follows:—

Net water required on 61,000 acres	73,200	ac.-ft.
Seepage losses at 20 per cent of the water diverted	18,300	"
Total water required	91,500	"

The following is an estimate of the average monthly requirement during the irrigation season:—

May	—12 per cent	11,000	ac.-ft.
June	—35 per cent	32,000	"
July	—30 per cent	27,400	"
August	—15 per cent	13,700	"
September	— 8 per cent	7,400	"
	100 per cent	91,500	"

There are no prior appropriations of any size on the Waterton River drainage basin and a study of the hydrometric records since 1908 shows that the above monthly amounts are available from the natural flow of the stream, even in a low water year.

Headworks.—The site for the diversion weir and intake is located on the Waterton river in the NW. ¼ section 18, township 5, range 27. The river at this point flows in a straight, well defined channel close to the left bank which is twenty-five feet in height. It is proposed to construct a concrete weir 550 feet in length with a maximum height of seventeen feet, which will raise the water-level to the required height to enable the diversion canal to be located on the first bench of the river valley, in a good clay material, well away from any flood action. No attempt was made to ascertain the character of the underlying material but from surface indications and for estimate purposes it is assumed that the headworks will rest on a pervious foundation. The weir was designed to pass a maximum flood of 20,000 acre-feet.

The original site surveyed for an intake is at Jenkin's canyon which is one and one-half miles further up the river. By locating the main canal at a higher elevation it is possible to divert water at this point by a low and inexpensive weir on a rock foundation. This advantage is offset by the extra length of canal required and the necessity of protecting at least a mile of canal bank from damage by high water in the river. Another disadvantage is that this location is in the river bottom which consists largely of gravel and the canal would probably need puddling to make it hold water. For these reasons the lower location was adopted although more expensive in first cost.

Main Canal.—The first three miles of canal from the lower intake will require some heavy earthwork in order to avoid steep side-hills. Roughly, a mile of this section will average a ten-foot cut and a tunnel 650 feet in length is necessary to

avoid a cut bank. There are also two 35-foot cuts which total 500 feet in length. The remaining twenty-seven miles of main canal will be of simple construction as far as earthwork is concerned. The most important structures required are a flume 870 feet in length to cross Foothill creek and a wood-stave pipe syphon nine feet in diameter and 1,600 feet long crossing Scott's coulee. The largest item of expense in this section will be to provide drops to take up 384 feet of excess grade between the intake and the Monarch branch. These drops are concentrated in four main series and are designed of permanent concrete construction.

ESTIMATE OF COST OF PROPOSED SOUTH MACLEOD IRRIGATION PROJECT

Headworks—		
Excavation (dry), 4,320 cu. yds. at $0.45	$ 1,944	
Excavation (wet), 8,320 cu. yds. at $1.50	12,480	
Concrete (plain), 6,919 cu. yds. at $17.50	121,082	
Concrete (reinforced), 480 cu. yds. at $35.00	16,800	
Gates, etc	8,911	
Rip Rap, 1,360 sq. yds. at $2	2,720	
Cofferdam	16,394	
		180,331
Excavation—		
Main Canal, 1,346,876 cu. yds. at $0.30	404,063	
Branches and distributaries, 861,852 cu. yds. at $0.30	258,556	
		662,619
Drops on Main Canal—		
Reinforced concrete, 5,242·25 cu. yds. at $40	209,690	
Excavation, Rip Rap, etc	6,781	
		216,471
Tunnel Horseshoe Shape (650 feet long)—		
650 lin. ft. at $48.80	31,720	
Inlet and outlet	4,340	
		36,060
Syphon, Scott's Coulee—		
1,600 ft. long		49,699
Flumes, Main Canal—		
Timber, 440,637 f. b. m. at $75	33,048	
Piling in structure, 7,476 lin. ft. at $0.20	1,495	
Piling driven, 6,160 lin. ft. at $0.70	4,312	
Inlets and Outlets, etc	4,232	
		43,087
General Timber Construction—		
Main Canal and Branches, 1,426,215 ft. b.m. at $75	106,966	
Excavation, Rip Rap, etc	63,755	
		170,721
General Concrete Structures—		
Reinforced, 737.12 cu. yds. at $45	33,170	
Plain, 49·6 cu. yds. at $20	992	
Rip Rap, corrugated pipe, etc	23,969	
		58,131
Right of Way—		
823·83 acres at $35	$ 28,834	
398·27 acres at $30	11,948	
		4,782
Fencing—		
12·9 miles at $400		5,160
Telephone—		
25 miles at $300		7,500
Total		$ 1,470,561
Engineering and Contingencies at 15%		220,584
Grand Total		$ 1,691,145

Total Irrigable Acres = 61,006·7 Cost per Acre = $27.72

The estimated cost of construction, $27.72 per irrigable acre is based on this year's prices. Since the estimate was made, unit prices have fallen considerably and it is believed that any change will be in a downward direction for some considerable time in the future. The cost of construction is very moderate for a scheme of this size. This is accounted for by the fact that the irrigable lands extend to within five miles of the intake, and the length of main canal required is comparatively short.

Organization.—The land owners under the project are already well organized. A petition for the formation of a district was forwarded to the Minister of Public Works of Alberta early in 1920. Further action was delayed until the field surveys were completed and the feasibility determined.

Plans.—The following plans have been completed in the required form for filing by the district:—

1. An index plan showing the boundaries of the district and the location of all canals. Scale 1 inch=1 mile.
2. Structural plans showing the irrigable areas in each quarter-section and the location of all canals and structures. Scale 1 inch=1,000 feet.

IRRIGATION DEVELOPMENT ASSOCIATION

This association is still actively engaged in furthering irrigation interests in southern Alberta. A great deal of activity which has been started by this organization has now been transferred to the officers of the various districts which have organized under the Irrigation Districts Act of Alberta.

There are many matters, however, which are common to all districts, and this organization affords a central medium through which they can be handled to better advantage than by the individual effort of each district.

WATER USERS ASSOCIATIONS AND DISTRICTS

The Lethbridge-Coaldale Water Users' Association is a voluntary organization which was formed in July, 1918, for the purpose of furthering the interests of the farmers under the Lethbridge section of the Canadian Pacific Railway Company's irrigation system located east of Lethbridge.

The activities of this organization have been to some extent superseded by four Water Users' Districts which have been organized more recently and which cover practically the same territory.

The organizations were formed under the Alberta Irrigation Districts Act for the purpose of operating that part of the system under which they were located, and are as follows in order of their location:—

Ready Made Water Users District.
East Lethbridge Water Users District.
Coaldale Water Users District.
Cameron Water Users District.

The first of these districts has been in successful operation ever since its erection in February, 1919. The three remaining were formed in 1920 but as yet have not shown any great activity.

UNITED AND LONE ROCK IRRIGATION DISTRICTS

The field-work was finished and an estimate made of these projects in 1919. The two projects contain about 23,265 acres irrigable, and it is estimated that the works can be built for about $19 per acre.

These two districts are watered from the same system. Under date of January 5, 1921, a majority of the owners of land under the Lone Rock District petitioned the Minister of Public Works of Alberta to be included in the United Irrigation District which had already been organized.

The Minister of the Interior gave his consent to this on February 28, 1920, and an order for the dissolution of the Lone Rock Irrigation District was signed by the Provincial Minister of Public Works on March 2, 1921. On the same day he issued an order changing the content of the United Irrigation District to include the former

Lone Rock District. The order provided that the enlarged United District should assume the liabilities of the former Lone Rock District. The Provincial Government employed Mr. D. W. Hays to make a report on this project and inform them as to the advisability of their guaranteeing the bonds of this district. This report has not been made public on the date this report is submitted.

THE SOUTHERN IRRIGATION DISTRICT

The order for the erection of this district was published in the *Alberta Gazette* March 31, 1920, where a description of the land included may be found.

The condition of this district is practically the same as set forth in the last annual report. Apparently nothing can be done towards constructing works to serve this land until we have finished the design and estimate for the whole Lethbridge Southeastern Project of which this is a part.

As stated in the last report, a portion of the area within this district is at present served by the Lethbridge section of the Canadian Pacific Railway Company's irrigation system. A party has been assigned to determine this year how much of the remaining land in the district is irrigable.

THE PROPOSED NEW DAYTON IRRIGATION DISTRICT

Petitions have been circulated for the formation of this district but the order for erection has not yet been issued. This district adjoins the Southern District on the east. The original intention was to make the line between range 15 and range 16 the eastern boundary. This, however, leaves out considerable land in townships 4 and 5, range 15, which can be served by the same distributary. It is, therefore, desirable that this land be included within the New Dayton District.

THE PROPOSED WARNER-MILK RIVER IRRIGATION DISTRICT

The petitions for the erection of this district have been submitted to the Provincial Government but the order for erection has not yet been issued. The condition of this district is the same as set forth in the last annual report. This project is a part of the Lethbridge Southeast Project and any development of this area must be considered in connection with development of the larger project.

THE PROPOSED MASINASIN IRRIGATION DISTRICT

This district adjoins the New Dayton Irrigation District on the east and includes the land in the area known as Tract 7-B (See report on Irrigation Surveys 1918-19) of the Lethbridge Southeast Project. Petitions are being circulated for the erection of the district.

LETHBRIDGE SOUTHEAST PROJECT

Plane table surveys for the development of this project were commenced in 1919, but only a small area was completed in that year. An attempt was made in 1920 to complete these surveys and for this purpose six parties were placed in the field, one location party consisting of twelve men and five plane table parties of twenty-seven men each.

The character of the work necessitated the employment of a very large number of experienced men and there was great difficulty in finding a sufficient number properly qualified, which materially delayed the work at the beginning of the season. After the parties were organized it was found necessary to devote considerable time to the training of some of the less experienced men, in order to get the parties into efficient working condition. In spite, however, of these difficulties, fairly good progress

was made. Work was begun about May 22 and the several parties thereafter took the field as soon as their personnel was complete. The first party was disbanded towards the end of October and it was found necessary to disband another party about the first of November. In both these cases the cause was the impossibility of keeping a sufficient number of properly qualified men. When by reason of loss of men a party fell below efficient working strength, it was disbanded and the remaining personnel was used, as far as possible, to fill vacancies in the other parties.

During the comparatively short field-season the five plane table parties surveyed a total area of 591,973 acres, which area was also tentatively classified in the field. The daily average rate per plane table day was 252·2 acres, computed on the basis of actual working days.

The method adopted for the work was to have the main canals and principal laterals located in advance of the plane table parties, so that the area to be covered by the latter would thereby be delineated, thus precluding the possibility of surveying any lands above the canals which of course were non-irrigable. The work was also planned so that the several plane table parties would never be widely separated, but always be in touch with one another and with a central camp where the inspector of plane table work made his headquarters and where there was maintained a portable field garage for the prompt repair of the large number of motor cars used in connection with this work.

Surveys were commenced in the district north and east of Magrath and south of Raymond and thence carried easterly to Pakowki lake and from that point north and west to Chin coulee and to the boundaries of the Taber Irrigation District.

The location party after completing the survey for the main canals and reservoir sites was moved on 22nd November to Waterton lakes where it was intended to make a complete survey on the ice of the upper lake, with a view to its use as a storage reservoir. The lake, however, did not freeze solidly enough to permit of such a survey and therefore only a small portion of the work was done, consisting chiefly of the survey around the townsite within the Waterton Lake Park. The party was disbanded about the middle of December, 1920.

In addition to the five survey parties previously referred to, a small party equipped with a light rotary rock drill, sunk a number of test holes at the proposed dam site on the St. Mary river at section 9, township 1, range 25, west of the 4th meridian, in order to determine the feasibility of constructing a dam on this site. This party took the field on February 17, 1920, but owing to severe weather and bad roads, the drill and other equipment which had been freighted from Cardston to the proposed site, a distance of seventeen miles, was not actually put into operation until March 3.

The equipment of the drilling party consisted of a McKiernan-Terry rotary drill, class "Z-1," an 8 horse-power gasoline engine, a centrifugal pump and the necessary equipment and accessories. During the field season ten test holes were sunk to depths varying from thirty-five to ninety feet. An accurate log of each hole and the progress of the work was kept plotted up to date on a map. From a study of the logs of the several test holes and the character of the rock it appears that this foundation is suitable for any type of dam. Comparative estimates must hereafter be made to determine the most suitable type, but the type which has been tentatively designed and seems to be the most economical is a rock-filled dam.

While survey work was in progress a careful examination of the land was undertaken by an additional party. This work commenced on the first of September and was continued until 10th November, during which period 267 soil groups, which were carefully chosen throughout the tract, were tested with the electrical bridge apparatus in order to determine their alkali content. Five samples, which were

assumed to be typical of the general soil conditions within the district, were forwarded to Ottawa for chemical analysis in order to confirm, or otherwise, the results obtained by the electrical bridge tests. The field tests with the electrical bridge showed the following results:—

130 groups showed no alkali.
82 groups showed alkali at depth of 5 feet.
37 groups showed alkali at depth of 3 to 5 feet.
8 groups showed alkali at depth of 1.5, 3 and 5 feet.
10 groups showed alkali at all depths.

All soils which showed a resistance when tested of less than 190 ohms were classed as alkaline.

While as a result of this soil examination certain small areas of land have been excluded and a few other small areas have been reserved for further examination, the district as a whole was found to be comparatively free from alkali and the soil is believed to be well adapted to irrigation.

In order that the results of the field-work might be plotted and correlated, a small office staff was maintained in Calgary through the season. This staff was somewhat augmented at the close of the field season by the addition of some of the field engineers. Considerable progress has been made in working up the results of the surveys but a very great deal of work yet remains to be done. The small office staff previously referred to will be employed continuously upon this work throughout the summer of 1921, while, at the same time, efforts will be made to complete the field-work.

CROWSNEST PASS IRRIGATION DISTRICT

During the year 1919 when it was realized that there was a probability of the Lethbridge Northern Irrigation Project being constructed, taking a water supply from the Oldman river, the occupants of lands higher up the stream became interested, and a number of resolutions from various local unions of the United Farmers of Alberta and also from the Board of Trade of Pincher Creek were forwarded to this office requesting the Dominion Government to make the necessary surveys to determine the feasibility of irrigating a large area of land tributary to the Oldman, Crowsnest and Castle rivers.

A standard twelve-man party organized in the spring of 1920 was accordingly placed in the field to make the necessary surveys and investigations.

This party was assembled at Cowley, Alberta, on May 29, and field-work was commenced at the "Gap" on the Oldman river, section 31, township 10, range 3, west of the 5th meridian on May 3. This work was continued until November 15, when the party had to disband on account of bad weather.

During the season the following work was completed:—

Contour survey of the "Gap" reservoir site on the Oldman river, townships 10 and 11, range 3, west of the 5th meridian.

Contour survey of reservoir site on Castle river at Canyon creek, township 6, range 2, west of the 5th meridian.

Contour survey of reservoir site on Gladstone creek, township 5, range 2, west of the 5th meridian.

Contour survey reservoir site on Pincher creek, township 6, range 30, west of the 4th meridian, and range 1, west of the 5th meridian.

Contour survey of reservoir site on Five-mile creek, township 9, range 29, west of the 4th meridian.

Contour survey of dam site at Castle river reservoir site, section 30, township 6, range 2, west of the 5th meridian.

Preliminary survey for main canals and lateral system over the Todd creek area, townships 8 and 9, ranges 1 and 2, west of the 5th meridian.

Preliminary survey for main canals and lateral system over the Pincher creek east area, township 6, ranges 29 and 30, west of the 4th meridian.

Reconnaissance and section line levels over the Pincher creek north area, townships 6 and 7, ranges 29 and 30, west of the 4th meridian, and range 1, west of the 5th meridian.

Preliminary survey for diversion canal from Gladstone and Mill creeks to the Pincher creek areas.

Reconnaissance of the Beaver creek area, townships 7 and 8, ranges 28 and 29, west of the 4th meridian.

The result of the field-work is summarized in the following tables. The estimates of cost are based upon 1920 prices and are merely approximations, subject to later and more detailed calculations.

SUMMARY OF RESERVOIRS—OLDMAN RIVER

——	Location	Flooded Area Acres	Capacity Ac.-ft.	Total Cost	Cost per Ac.-ft.	Remarks
				$ cts.	$ cts.	
'Gap' reservoir.......	Tps. 10 and 11, Rge. 3, W. 5th M.	1,500	90,000	612,232 50	6 80	Rock-fill concrete faced dam.
Castle River reservoir	Tp. 6, Rge. 2 and 3, W. 5th M.	800	30,000	219,290 50	7 30	" "
Canyon Creek reservoir	Tp. 6, Rge. 2, W. 5th M.	1,000	40,000	292,974 00	7 32	" "
Pincher Creek reservoir	Tp. 6, Rge. 30, W. 4th M.	200	5,000	120,000 00	24 00	" "
Gladstone Creek reservoir.	Tp. 5, Rge. 2, W. 5th M.	30	1,000	30,000 00	35 00	Cost not worked out in detail.
Five-mile Creek reservoir.	Tp. 9, Rge. 29, W. 4th M.	200	3,500	105,000 00	30 00	Earth dam.

SUMMARY OF COSTS—CROWSNEST IRRIGATION DISTRICT

——	Estimated Irrigable Acres	Estimated Cost Structures	Estimated Cost Main Canals	Total Cost	Cost per Acre
Todd Creek area..............	8,600	$201,627 50	$221,405 00	$423,032 50	$49 20
Pincher Creek East area......	7,200	258,720 00	64,157 50	322,877 50	44 84
Pincher Creek North area.....	9,000	Detail costs $50 per acr	not taken o e.	ut. Obviou	sly high and in excess of
Beaver Creek area............	2,600	(Area and c	ost from rec	onnaissance *143,495 00	only) $55.30. 65 parcels of 40 acres
Cowley area..................	3,000	Detail costs $50 per acr	not taken o e.	ut. Obviou	sly high and in excess of

*Includes Reservoir—$120,000.

Water for the Todd creek area would be taken from the Oldman river at section 10, township 10, range 2, west of the 5th meridian. A main canal ten miles in length is required to reach the irrigable lands. Although the estimated cost is $49.20 per irrigable acre, which is considerably lower than at first thought possible, four miles of this canal is on side-hill in excess of forty degrees and it is considered that this piece of canal would be very difficult to construct and maintain. Although allowance has been made in the estimate for heavy work here and a number of bench flumes, it is doubtful whether the scheme could be constructed for the figure shown in the table. These four miles of canal make the feasibility of the project very uncertain because it is not possible to determine just what contingencies may arise in construction. This scheme is not considered a feasible one at the present time.

The estimate of cost to irrigate the Pincher creek north area is necessarily very approximate. The irrigable area was determined by running levels over section lines, and although some preliminary line has been run for main canal, it was found that the route was so difficult that the scheme was not considered a feasible one, and therefore was not surveyed in any detail. The estimate of cost has been based partially on actual surveys, but largely upon a reconnaissance. This scheme is not considered feasible at the present time.

More detailed surveys were made of the Pincher creek east area. Except for the storage reservoir required on Pincher creek, this is a very cheap and simple scheme. Water can be carried to the irrigable lands by means of a main canal four miles in length, and even with the comparatively expensive reservoir required on Pincher creek, the estimated cost per acre is less than $45. The land in this area is comparatively heavy and not so well adapted for irrigation as the Pincher creek north area.

No surveys have yet been made of the Beaver creek area. It is estimated, however, that there are some 9,000 acres which could be irrigated. A study has been made of the water supply of Beaver creek and although the records of stream flow are very incomplete it is estimated that there is only a sufficient quantity of water, with a storage reservoir on Five-mile creek of 3,500 acre-feet capacity, to irrigate some 2,600 acres. A very approximate estimate of cost to irrigate this area was made and the cost determined at $55.30 per acre.

A reconnaissance was made of the Cowley area and the estimated cost is based on this reconnaissance. Water could be carried to this area by means of a grade canal twelve miles in length, or by utilizing the waterpower available at the falls near Lundbreck and pumping to a point on the side-hill carrying the water to the land by a canal about five miles in length. Either of these schemes would be expensive and the project is not considered feasible at the present time.

There are, no doubt, many other small schemes along the foothills which may prove to be feasible, some of which will be investigated during the coming season. It would seem that these areas can be more economically irrigated from the smaller streams than from the rivers.

CYPRESS LAKE RESERVOIR PROJECT

As stated in the report for last year, Mr. French made a reconnaissance survey of the irrigation possibilities in the valleys of Battle creek and Frenchman river and submitted a report early in 1920.

During the field-season of 1920 a party was placed on this project with Mr. Wotherspoon in immediate charge and under the general direction of Mr. French.

Early in June the assistant chief engineer, accompanied by Mr. French, made a further examination of the conditions on both streams and it was decided that on account of the many evidences of alkali in the bottom lands of both valleys, and especially those of the Frenchman, it would be better to develop first the large block of land in the vicinity of Consul, Vidora, and Robsart as suggested in Mr. French's report.

After some field-work had been done on an extension of the Wilkes Brothers ditch it was found that a much better location could be obtained by starting at a point on the proposed outlet canal to the reservoir just before it drops into Battle creek above the Wilkes Brothers dam and run the main canal around the hillside about ten feet in elevation above the ditch of Wilkes Brothers.

This additional elevation is just sufficient to permit a location through the saddle in the northeast quarter of section 34, township 5, range 27, west of the 3rd meridian. This main canal was surveyed to a point about half a mile southwest of the town of

Robsart, a total distance of twenty-two and a half miles from the outlet in the reservoir. Beyond this point two laterals were run in the field. All the main laterals were run out and the remainder projected on the topographic map. Levels were run around all quarter-sections and the topography sketched in.

This canal commands the land lying to the south between it and the flats around Lonesome lake. The total irrigable land in this tract is about 11,580 acres.

An extension of the McKinnon ditch was also surveyed which would add 425 acres, but this may upon further investigation prove too heavily impregnated with alkali to warrant irrigation. If the area irrigated is limited to sixty acres to the quarter-section there would be only 9,460 acres irrigable, exclusive of the McKinnon extension.

Water Supply.—The present project is for an irrigable tract of land in the Battle Creek valley only, and as Belanger and Davis creeks are direct tributaries of the Frenchman river, it is not considered advisable to divert any waters of these creeks into the Cypress Lake reservoir at the present time.

The flood flow of Belanger and Davis creeks is small when compared with Battle creek, and the canals round the hillside, especially where facing southwest, would be badly covered with ice and drifting snow during the winter and in all likelihood at times be rendered useless during the first period of the spring run-off. The Battle creek intake canal is more in the open and not likely to get badly drifted.

If it is considered necessary at any future date to divert Belanger and Davis creeks into the Cypress Lake reservoir this can be done without in any way interfering with the work done under the present project.

If the waters of Belanger creek alone were proposed at any future time to be added to the reservoir, it would probably be found feasible to divert this creek into Sucker creek by a canal through a low part in the ridge between the two valleys near section 36, township 6, range 26, west of the 3rd meridian. The present supply to Cypress lake is derived from:—

1. Oxarart creek.
2. Sucker creek.
3. Surface drainage around lake.
4. Underground springs.

The work as at present proposed will add a supply from Battle creek.

The records from 1912 to 1920 inclusive on these sources of supply show that an average of 40,504 acre-feet per year is available and that during 1917 it reached a maximum of nearly 70,000 acre-feet.

While the records of Belanger and Davis creeks previous to 1918 are not complete, they indicate that the run-off of these two creeks would add an average of about 6,000 acre-feet per year.

To provide storage for more than 90,000 acre-feet would not be economical. A reservoir of this capacity would store the run-off of two wet years in succession and would not require to be enlarged if at a later date it is decided to use the flood waters of Belanger and Davis creeks. Assuming that the average run-off of 40,504 acre-feet is available every year, we find that with 90,000 acre-feet storage it is possible to supply in addition to the present demands about 10,000 acres with the full duty of eighteen inches, or 12,000 acres with the reduced duty of fifteen inches in depth.

If this project had been in existence during the years over which the records extend, they would in one year, 1914, have been short of water and would probably have had sufficient for only about half their land. In the other eight years, however, they would have received the full amount as above.

Several alternative dam sites have been investigated and it has been decided that the best sites are as proposed and shown on the 1913 plans. Under the present project it is only proposed to raise the present water-level of the lake sixteen feet. The

dams are earth-fill with riprap face inside. The west dam in the centre of section 15, township 6, range 27, west of the 3rd meridian is 2,500 feet and the east dam near the centre of section 24, township 6, range 26, west of the 3rd meridian, is 3,300 feet in length on the crest line, with a height of 26·5 feet in both cases.

Intake.—The intake of the Battle Creek canal is located in the southwest quarter of section 2, township 6, range 28, west of the 3rd meridian. The maximum discharge record of Battle creek at Tenmile is given as 1,366 second-feet on May 9, 1917. The original canal was designed with a capacity of 1,000 second-feet. This has been increased to a capacity of 1,386 second-feet, from the intake to Oxarart creek, and 1,885 second-feet from Oxarart creek to the reservoir. The dam at the intake consists of an earth-fill 1,300 feet in length; it is about twenty feet in height over the present bed of Battle creek; except for this short distance over the creek the maximum height is ten feet. A concrete spillway 130 feet in length, sufficient to carry 1,400 second-feet, is provided. The headgates consist of four gates, each four feet by nine feet, supported by concrete piers and curtain walls.

Outlets.—The outlet into the main canal at the south end of the west dam consists of two 4 feet 6 inches by 5 feet headgates and concrete openings 5 feet 3 inches by 5 feet, the floor of the openings being three feet below the low water-level of the reservoir. When the water is one foot above the low water-level it would be four feet deep in the culvert outlets; this would give a discharge of 126 second-feet, which is the full supply required for the project and under a head of two feet a discharge of 405 second-feet.

An outlet of the same capacity into the Frenchman river is allowed for in the dam at the east end of the reservoir. The floor level of this outlet is the same as the present overflow level of the lake, or three feet above the level of the one in the west dam. It is not considered necessary to have any spillways to the reservoir, as the sluice-gates into the new canal and the Frenchman river working under a small head have a greater capacity than the flood discharge of Sucker and Oxarart creeks.

The following is a summary of the estimated cost:—

Headworks on Battle creek and intake canal..	$226,321 80
East dam, Cypress lake reservoir..	141,704 00
West dam, Cypress lake reservoir..	88,328 00
Outlet canal reservoir to Battle creek..	85,083 50
	$541,437 30
Engineering and contingencies, 10 per cent..	54,143 73
Total estimated cost..	$595,581 03
On the basis of 90,000 acre-feet—$6.61 per acre-foot.	
Main canal and laterals..	$110,455 00
Engineering and contingencies, 10 per cent..	11,045 50
Total..	$121,500 50
Right of way..	5,594 00
Total estimated cost..	$127,094 50
Total cost of project, exclusive of McKinnon Extension..	722,675 53

On the basis of 11,580 acres this is about $63 per acre. The cost per acre would be reduced to about $60 if the McKinnon extension is included.

This estimate is based upon unit costs which, in view of the general reduction of prices, are considered high and it is therefore probable that this project could be built for fourteen per cent less, or about $54.60 per acre.

The examination of the soil of this tract shows that in general the top eighteen inches in depth is practically free from alkali. Below this, however, to a depth of about six feet, the soil is rather heavily impregnated.

It is probable that this land can be irrigated successfully if the water table can be kept below eighteen inches. This depends largely upon the character of the subsoil, which will be investigated further this season.

NORTH SASKATCHEWAN DIVERSION PROJECT

A history and general outline of the scope of this project is contained in the last annual report. No further field-work was undertaken during 1920.

The proposal for this scheme is to divert the North Saskatchewan and Red Deer rivers to provide water for irrigation and domestic uses to an immense tract of land extending from the Berry creek district in Alberta to the neighbourhood of Saskatoon in Saskatchewan. The small amount of reconnaissance which has been completed to date has only served to outline in a general way some of the possibilities of this project.

During 1921 preliminary surveys will be made to determine the feasibility or otherwise of diverting water from the above-mentioned rivers into Buffalo lake as a reservoir, and also the feasibility of locating a canal from Buffalo lake to the irrigable areas. In addition it is proposed to run a system of levels over the township lines of the irrigable tract to obtain a general knowledge of its extent and suitability for irrigation.

THE LITTLE BOW IRRIGATION PROJECT

On January 26, 1921, a meeting of the farmers representing owners of land along the Little Bow river bottoms was held in Carmangay, Alberta, for the purpose of organizing an irrigation district. It is proposed to divert water from the Highwood river into the Little Bow river at the town of High River.

In 1919 this branch in co-operation with the Provincial Public Works Department selected a new site for the construction of permanent headworks for the diversion of the fifty cubic feet per second of water which the Provincial Government had been granted to supply the domestic rights on the Little Bow river. This site is located just below the Canadian Pacific Railway bridge at the town of High River.

This proposed district plans to join with the Provincial Government in building new headworks large enough for both diversions. It is proposed that the district as a whole shall maintain the headworks and that each farmer shall construct and maintain his own pumping plant for the irrigation of his own land. There are thirty-two separate tracts varying from six acres to two hundred and twenty-five acres in size, all situated less than forty feet above the river. The tracts begin about eighteen miles above Carmangay in section 5, township 15, range 25, west of the 4th meridian, and extend along the Little Bow river to section 3, township 14, range 20, about twenty-six miles below.

The total area is about 2,786 acres.

The landowners have engaged Mr. John Haddin of Calgary as their engineer and are making their own surveys.

DUTY OF WATER

Duty of water investigations were carried on at Brooks, Ronalane and Coaldale as in former years under the general supervision of Mr. W. H. Snelson. Mr. E. E. Eisenhauer collected the data at Coaldale and Mr. A. Hildenbrand, of the Canada Land & Irrigation Company, operated the experimental plots at Ronalane. The results obtained and the conclusions reached are discussed hereunder.

BROOKS EXPERIMENT STATION, 1920

The season of 1920 was in many respects the most unfavourable for crops, in the Brooks district, of any since 1917. The month of April was the coldest on record since 1916, having a mean monthly temperature of only 33.2° as compared with 46° for 1918 and 43.8° for 1919. The ground remained cold and wet and was not in a suitable condition for seeding until May 5, two weeks later than seeding operations commenced in 1919.

Frost occurred on twenty-four nights during April, the last frost for the month occurring on the thirtieth. Precipitation was 1.16 inches.

During May frost occurred on the 1st, 2nd, 3rd, 4th, 22nd and 29th. Precipitation was 0.88 inch. The mean temperature was 50.8°, the lowest for May since 1916.

June had a mean temperature of 59.4° with 1.52 inches precipitation, 1.33 inches of which fell in a good rain between the 16th and 19th. This month was about normal. Light frosts occurred on the 1st, 3rd and 9th but did no damage to the crops.

July had a mean temperature of 69° with 1.41 inches precipitation, being slightly warmer than in 1918 and 1919.

August had a mean temperature of 64.6° practically the same as prevailed in August of 1918 and 1919, but there was no precipitation whatever. A very disastrous wind on the seventeenth of the month caused much shelling of ripened grain throughout the district.

September had no precipitation. Mean temperature was 55.5°.

The total precipitation April to September inclusive was 4.97 inches; the mean temperature for the same period was 55.6°.

On the whole this was a very dry season, made more unfavourable for crops by the late cold spring and the very heavy crop-damaging winds of the latter part of August.

The results of the past season's work are given in the tables following:

In studying the tables it is to be noted that the column *Total Depth Received* is the sum if *duty of water and precipitation.* The column *Total Depth Used in Growing the Crop* shows the depth of water actually used in growing the crop, as determined by soil moisture tests.

The following schedule shows the rotation schedule adopted in order that the general fertility of the farm may be maintained, and that certain crop series may have from year to year, as near as may be, the same conditions of soil fertility.

For 1920 the duty of water for wheat has been determined under four different conditions of soil fertility. (1) immediately following a leguminous crop; (2) following potatoes; (3) following wheat after wheat; and (4) following wheat after potatoes. In a similar manner the duty of water for oats is found under four different conditions of soil fertility, barley two and potatoes two.

Rotation A.—alfalfa five years, potatoes, wheat, flax.

Rotation B.—alsike clover four years, roots, oats, wheat, oats.

Rotation C.—grass three years, potatoes, barley, wheat.

Rotation D.—red clover two years, oats, barley.

Rotation E.—Peas, wheat, oats, barley.

From this schedule it is possible to have in each season grain crops (either wheat, oats or barley) coming immediately after legumes or grasses, second year after legumes, and third year after legumes, thus giving us an opportunity of securing practical evidence of the phenomena that crops growing on fertile soil require less water to produce a maximum yield than when growing upon soils where by virtue of successive cropping, without the introduction of organic matter or legumes, the available plant food has been materially reduced. A striking illustration of this point occurs in the four oat series, where on plot 74C, when oats followed red clover, 131 bushels per acre were grown with two four-inch irrigations, as compared with plot 69A where 108 bushels per acre were grown with five four-inch irrigations where oats followed roots, and with plot 65A where eighty-seven bushels per acre were grown with five four-inch irrigations where oats followed two grain crops.

Wheat.—In rotation "E" the maximum yield of 51 bushels per acre was produced with a total depth of 2·08 feet of water.

In rotation "C" the maximum yield of 47·4 bushels per acre was produced with a total depth of 2·08 feet of water.

In rotation "B" the maximum yield of 43·6 bushels per acre was produced with a total depth of 1·74 feet of water.

In rotation "A" the maximum yield of 33·8 bushels per acre was produced with a total depth of 2·08 feet of water.

Summarizing the results from the four wheat series it is shown that the maximum yields were produced with an average total depth of 1·99 feet of water, of which 0·41 foot was received as rainfall. In each series additional irrigations produced decreases in yield. The dry plots yielded from 9·4 to 15 bushels per acre. The maximum yield of the four series, 51 bushels per acre, with total depth of 2·08 feet, was from land which grew peas in 1919.

Oats.—In rotation "D" the maximum yield of 133 bushels per acre was produced with a total depth of 1·41 feet of water. In rotation "B" the maximum yield of 108 bushels per acre was produced with a total depth of 2·08 feet. In rotation "E" the maximum yield of 108 bushels per acre was produced with a total depth of 2·41 feet. In rotation "B1" the maximum yield of 87 bushels per acre was produced with a total depth of 2·08 feet of water.

Summarizing the results from four oat series it is shown that the maximum yields were produced with an average total depth of 1·99 feet of water, of which 0·41 foot was received as rainfall. The dry plots yielded from 8 to 60 bushels per acre. In series "D," "B" and "B1" additional irrigations produced decreases in yield. In series "E" the maximum yield is coincident with the maximum depth received.

The Maximum yield of the four series, 133 bushels per acre, with total depth of 1·41 feet of water, was from land which grew clover in 1919.

Flax.—The maximum yield of flax, 17·3 bushels per acre, was produced with a total depth of 1·74 feet of water, of which 0·41 foot was received as rainfall. Additional irrigations decreased the yield. The dry plot produced 4·9 bushels per acre.

Barley.—In rotation "E" the maximum yield of 56 bushels per acre was produced with a total depth of 2·08 feet of water. In rotation "D" the maximum yield of 69 bushels per acre was produced with a total depth of 2·41 feet.

Summarizing results from two barley plots it was shown that the maximum yields were produced with an average total depth of 2·25 feet of water, of which 0·41 foot was received as rainfall. The dry plots yielded from 3 to 4 bushels per acre.

Alfalfa Seed Production.—The maximum yield of alfalfa seed, 8·9 bushels per acre, was produced with a total depth of 1·16 feet of water, of which 0·41 foot was received as rainfall. This yield was produced from that portion of plot 41D which was seeded in drills seven inches apart. An additional irrigation decreased the yield, giving a high percentage of green and shrivelled seeds. The dry plot produced no seed.

Where the alfalfa was sown in rows, the maximum yield, 8·33 bushels per acre, was produced with a total depth of 1·16 feet of water; the dry plot yielded 0·4 bushel per acre.

Where the alfalfa was sown in hills, the maximum yield, 4·87 bushels per acre, was produced with a total depth of 1·16 feet of water. The dry plot produced 0·8 bushel per acre.

For the last two methods of seeding an additional irrigation caused a decrease in yield.

The alfalfa sown in drills has shown the best results this year.

The heavy wind which occurred on August 17 caused considerable damage to the alfalfa seed crop which was growing upon plots 41A, B and C. These three plots, having received a smaller quantity of irrigation water than plots 41D and E, were well ripened when the wind came and the seed was blown off and scattered on the ground. The seed on plots 41D and E was then in a green and unripe state and suffered little if any from the wind. The figures for the yield of seed from plots 41A, B and C were

obtained from calculations based upon careful examinations and measurements made upon the plots before the wind, and although they are not as exact as would have been the case had the seed been threshed, they are fairly reliable and show the comparative yields for the series.

Peas.—The maximum yield of peas, 68 bushels per acre, was produced with a total depth of 2.41 feet of water. The dry plot produced 4.3 bushels per acre. Plots which received depths of 2.74 and 3.08 feet of water produced 56 and 53.8 bushels per acre respectively The results obtained during the past two years indicate that peas require a total depth of about 2.30 feet of water to produce maximum yields, this being a higher water requirement than has been found for any of the other grains under test.

Potatoes.—In rotation "C," Early Ohio potatoes, the maximum yield, 185 bushels per acre, was produced with a total depth of 1.24 feet of water. The dry plot produced 20 bushels per acre.

In rotation "A," Gold Coin potatoes, the maximum yield, 217 bushels per acre, was produced with a total depth of 1.24 feet of water. The dry plot produced 24 bushels per acre.

In both rotations an additional irrigation decreased the yield. The water was applied to the potatoes in two and three-inch irrigations.

Summarizing the results of the two potato series it is shown that the maximum yields were produced with an average total depth of 1.24 feet of water, of which 0.41 foot was received as rainfall.

Alfalfa Hay.—The maximum yield of alfalfa hay, 6·48 tons per acre, was produced with a total depth of 2·08 feet of water. Additional depths up to 3·91 feet produced no increase in the yield. The dry plot produced 0.30 ton per acre, all of which was taken off at the first cutting. Three cuttings were made in all.

Grass Hay.—The maximum yield of grass hay, 1.75 tons per acre, was produced with a total depth of 1·74 feet of water, of which 0·41 foot was received as rainfall. Additional irrigations produced no increase in yield.

Sugar Beets.—The maximum yield of sugar beets, 16 tons per acre, was produced with a total depth of 2.08 feet of water, being coincident with the maximum depth received. This is, however, only a very slightly increased yield over the plot which received a total depth of 1.74 feet and produced 15.7 tons per acre.

Squaw Corn.—The maximum yield, 2.90 tons of corn per acre, was produced with a total depth of 1.74 feet of water. An additional irrigation decreased the yield.

Dry Land Wheat.—Wheat sown on dry land which had been in wheat in 1918 and 1919 produced at the rate of 11.2 bushels per acre. Wheat sown on dry land which had been summer-fallowed in 1919 produced at the rate of 20 bushels per acre.

SCHEDULE A.

WHEAT (MARQUIS), 1920

Rotation E

Plot No.	Area in Acres	Irrigation — Date and Depth Applied in Acre-feet per Acre: June 7	June 15	June 23	June 29	June	July 1	July 9	July 15	July 24	July 26	July 29	Aug. 3	Aug. 7	Duty of Water	Rainfall April 1 to Harvest	Total Depth Rec'd	Total Depth Used in Growing the Crop.	Yield per Acre Bus.	Remarks
32	0.705														0.00	0.41	0.41	0.64	10.0	Cut Aug. 2
31	0.084						0.33								0.33	0.41	0.74	0.97	30.9	" 18
36	0.240				0.33						0.34				0.67	0.41	1.08	1.20	41.9	" 18
37	0.223			0.33					0.33			0.34			1.00	0.41	1.41	1.47	47.6	" 18
38	0.220		0.33					0.33			0.34		0.33		1.33	0.41	1.74	1.60	50.0	" 18
39	0.225	0.33			0.33				0.34			0.33		0.34	1.67	0.41	2.08	1.94	51.0	" 18
40	0.225	0.33		0.33				0.34			0.33		0.33	0.34	2.00	0.41	2.41	2.28	48.3	" 18
33	0.070				0.50					0.50					1.00	0.41	1.41	1.34	41.8	" 19
34	0.091			0.50					0.50			0.50			1.50	0.41	1.91	1.94	44.7	" 18
35	0.081		0.50					0.50			0.50		0.50		2.00	0.41	2.41	2.60	43.6	" 19

Rotation C

Plot No.	Area in Acres	June 5	June 14	June 21	June 25	June 30	July 6	July 12	July 21	July 27	July 30	July	Aug. 6	Aug.	Duty of Water	Rainfall April 1 to Harvest	Total Depth Rec'd	Total Depth Used in Growing the Crop.	Yield per Acre Bus.	Remarks
91A	0·039														0·00	0·41	0·41	0·26	15·0	Aug. 12
91B	0·037					0·33									0·33	0·41	0·74	0·83	25·0	" 12
91C	0,035				0·33				0·34						0·67	0·41	1·08	1·14	35·7	" 12
91D	0·056			0·33				0·33		0·34					1·00	0·41	1·41	1·41	40·0	" 12
91E	0·038		0·33				0·33		0·34		0·33				1·33	0·41	1·74	1·75	44·3	" 16
92A	0·038	0·33			0·33			0·34		0·33			0·34		1·67	0·41	2·08	2·03	47·4	" 16
92B	0·037	0·33		0·33			0·34		0·33		0·33		0·34		2·00	0·41	2·41	2·04	46·0	" 16
92C	0·037				0·50				0·50						1·00	0·41	1·41	1·32	31·0	" 12
92D	0·047			0·50				0·50		0·50					1·50	0·41	1·91	2·01	42·7	" 16
92E	0·051		0·50				0·50		0·50		0·50				2·00	0·41	2·41	2·18	42·5	" 16

ROTATION B

		5	15	22	26	30	6	13	21	27	31		6							
66A	0·014														0·00	0·41	0·41	0·50	12·0	Aug. 3
66B	0·024					0·33									0·33	0·41	0·74	0·86	23·6	" 12
66C	0·024				0·33				0·34						0·67	0·41	1·08	1·20	32·2	" 12
66D	0·024			0·33				0·33		0·34					1·00	0·41	1·41	1·46	39·8	" 17
66E	0·023		0·33				0·33		0·34		0·33				1·33	0·41	1·74	1·96	43·6	" 17
67A	0·042	0·33			0·33			0·34		0·33			0·34		1·67	0·41	2·08	2·11	37·8	" 18
67B	0·032	0·33		0·33			0·34		0·33		0·33		0·34		2·00	0·41	2·41	2·05	30·0	" 18
67C	0·032				0·50				0·50						1·00	0·41	1·41	1·23	29·5	" 12
67D	0·027			0·50				0·50		0·50					1·50	0·41	1·91	2·09	36·4	" 17
67E	0·031		0·50				0·50		0·50		0·50				2·00	0·41	2·41	2·49	30·8	" 17

ROTATION A

		5	14	21	25	30	6	12	21	26	31		6							
50A	0·020														0·00	0·41	0·41	0·41	9·4	Aug. 3
50B	0·032					0·33									0·33	0·41	0·74	0·69	19·3	" 12
50C	0·033				0·33				0·34						0·67	0·41	1·08	1·01	29·0	" 12
50D	0·034			0·33				0·33		0·34					1·00	0·41	1·41	1·35	30·3	" 12
50E	0·034		0·33				0·33		·34		0·33				1·33	0·41	1·74	1·73	32·3	" 12
51A	0·033	0·33			0·33			0·34		0·33			0·34		1·67	0·41	2·08	1·87	33·8	" 12
51B	0·034	0·33		0·33			0·34		0·33		0·33		0·34		2·00	0·41	2·41	2·17	30·3	" 12
51C	0·034				0·50				0·50						1·00	0·41	1·41	1·41	23·2	" 12
51D	0·033			0·50				0·50		0·50					1·50	0·41	1·91	1·70	30·1	" 12
51E	0·034		0·50				0·50		0·50		0·50				2·00	0·41	2·41	1·98	24·7	" 12

SCHEDULE B.

OATS (BANNER), 1920

Rotation D

Plot No.	in Acres	Irrigation — Date and Depth Applied in Acre-feet per Acre: June 5	June 14	June 21	June 26		July 1	July 7	July 12	July 22	July 27	July 31	Aug. 6		Duty of Water	Rainfall April 1 to Harvest	Total Depth Rec'd	Total Depth Used in Growing the Crop	Yield per Acre	Remarks: Cut
74A	0·030														0·00	0·41	0·41	0·79	60	Aug. 12
B	0·033						0·33								0·33	0·41	0·74	1·54	103	" 12
C	0·034				0·33					0·34					0·67	0·41	1·08	1·72	131	" 19
D	0·034			0·33					0·33		0·34				1·00	0·41	1·41	1·75	132	" 23
E	0·034		0·33					0·33		0·33		0·34			1·33	0·41	1·74	1·77	132	" 23
75A	0·032	0·33			0·33				0·34		0·33		0·34		1·67	0·41	2·08	1·78	124	" 23
B	0·033	0·33		0·33				0·34		0·33		0·33	0·34		2·00	0·41	2·41	1·95	119	" 23
C	0·034				0·50					0·50					1·00	0·41	1·41	1·72	133	" 23
D	0·034			0·50					0·50			0·50			1·50	0·41	1·91	2·01	132	" 19
E	0·033		0·50					0·50		0·50		0·50			2·00	0·41	2·41	2·26	106	" 19

Rotation B

Plot No.	in Acres	June 5	June 14	June 21	June 25		July 1	July 7	July 13	July 21	July 27	July 31	Aug. 6		Duty of Water	Rainfall April 1 to Harvest	Total Depth Rec'd	Total Depth Used in Growing the Crop	Yield per Acre	Remarks: Cut
68A	0·033														0·00	0·41	0·41	0·80	30	Aug. 12
B	0·036						0·33								0·33	0·41	0·74	0·90	59	" 12
C	0·036				0·33					0·34					0·67	0·41	1·08	1·05	75	" 12
D	0·036			0·33					0·33		0·34				1·00	0·41	1·41	1·40	91	" 16
E	0·036		0·33					0·33		0·34		0·33			1·33	0·41	1·74	1·60	105	" 16
69A	0·036	0·33			0·33				0·34		0·33		0·34		1·67	0·41	2·08	1·75	108	" 16
B	0·036	0·33		0·33				0·34		0·33		0·33	0·34		2·00	0·41	2·41	1·95	100	" 16
C	0·034				0·50					0·50					1·00	0·41	1·41	1·20	96	" 16
D	0·035			0·50					0·50		0·50				1·50	0·41	1·91	1·72	87	" 16
E	0·033		0·50					0·50		0·50		0·50			2·00	0·41	2·41	2·08	98	" 19

ROTATION E

		8	15	22	26	28	2	8	14	24	28		2	6						
7A	0·035														0·00	0·41	0·41	0·57	22	Aug. 11
6	0·200						0·33								0·33	0·41	0·74	0·88	62	" 11
5	0·239				0·33					0·34					0·67	0·41	1·08	1·14	71	" 11
4	0·234			0·33					0·33		0·34				1·00	0·41	1·41	1·45	84	" 11
3	0·233		0·33					0·33		0·34					1·33	0·41	1·74	1·60	92	" 11
7B	0·234	0·33				0·33			0·34		0·33			0·34	1·67	0·41	2·08	1·97	97	" 14
1	0·232	0·33		0·33				0·34		0·33			0·33	0·34	2·00	0·41	2·41	2·35	94	" 14
10	0·234					0·50				0·50					1·00	0·41	1·41	1·32	70	" 14
9	0·234			0·50					0·50		0·50				1·50	0·41	1·91	1·79	91	" 11
8	0·226		0·50					0·50		0·50			0·50		2·00	0·41	2·41	2·45	108	" 14

ROTATION B-1

		5	14	21	25	30	6	13	21	27	31		6							
64A	0·012														0·00	0·41	0·41	0·46	8	Aug. 12
B	0·036					0·33									0·33	0·41	0·74	0·94	52	" 12
C	0·035				0·33				0·34						0·67	0·41	1·08	1·02	70	" 12
D	0·035			0·33				0·33		0·34					1·00	0·41	1·41	1·07	77	" 12
E	0·035		0·33				0·33		0·34		0·33				1·33	0·41	1·74	1·17	81	" 16
65A	0·033	0·33			0·33			0·34		0·33			0·34		1·67	0·41	2·08	1·62	87	" 12
B	0·036	0·33		0·33			0·34		0·33		0·33				2·00	0·41	2·41	1·80	80	" 12
65C	0·036				0·50				0·50						1·00	0·41	1·41	1·54	73	" 12
65D	0·035			0·50				0·50		0·50					1·50	0·41	1·91	1·60	87	" 16
E	0·035		0·50				0·50		0·50		0·50				2·00	0·41	2·41	2·09	85	" 16

FLAX (NORTH DAKOTA RESISTANT NO. 73), 1920

ROTATION "A" SCHEDULE "C"

Plot No.	Area Acres	Irrigation — Date and Depth Applied in Acre-feet per Acre: June 5	June 14	June 21	June 25	June 30	July 6	July 12	July 21	July 26	Aug. 31	Aug. 6	Duty of Water	Rainfall April 1 to Harvest	Total Depth Rec'd	Total Depth Used in Growing the Crop	Yield per Acre	Remarks
48A	0.029												0.00	0.41	0.41	0.63	4.9	Cut Aug. 18
48B	0.033					0.33							0.33	0.41	0.74	0.88	7.7	
48C	0.031				0.33				0.34				0.67	0.41	1.08	1.00	11.1	
48D	0.031			0.33				0.33		0.34			1.00	0.41	1.41	1.03	13.6	
48E	0.031		0.33				0.33		0.34		0.33		1.33	0.41	1.74	1.07	17.3	
49A	0.031	0.33			0.33			0.34		0.33		0.34	1.67	0.41	2.08	1.39	15.4	
49B	0.033	0.33		0.33			0.34		0.33		0.33	0.34	2.00	0.41	2.41	1.88	13.1	
49C	0.034				0.50				0.50				1.00	0.41	1.41	1.61	14.9	
49D	0.033			0.50				0.50		0.50			1.50	0.41	1.91	1.71	16.8	
49E	0.034		0.50				0.50		0.50		0.50		2.00	0.41	2.41	1.93	14.5	

SCHEDULE "D"

BARLEY (O.A.C. NO. 21), 1920

ROTATION "E"

Plot No.	Area Acres	Irrigation — Date and Depth Applied in Acre-feet per Acre: June 7	June 15	June 23	June 26	June 28	July 2	July 8	July 14	July 23	July 28	Aug. 3	Aug. 7	Duty of Water	Rainfall April 1 to Harvest	Total Depth Rec'd	Total Depth Used in Growing the Crop	Yield per Acre	Remarks
14B	1.112													0.00	0.41	0.41	0.45	4	Cut August
15	0.237						0.33							0.33	0.41	0.74	0.91	24	
16	0.242				0.33					0.34				0.67	0.41	1.08	1.15	41	
17	0.240			0.33					0.33		0.34			1.00	0.41	1.41	1.40	45	
18	0.214		0.33					0.33		0.34		0.33		1.33	0.41	1.74	1.60	51	
19	0.190	0.33			0.33				0.34		0.33		0.34	1.67	0.41	2.08	1.82	56	
20	0.232	0.33		0.33				0.34		0.33		0.33	0.34	2.00	0.41	2.41	2.08	54	
11	0.234					0.50				0.50				1.00	0.41	1.41	1.24	47	
12	0.234			0.50					0.50		0.50			1.50	0.41	1.91	1.89	53	
13	0.234		0.50					0.50		0.50		0.50		2.00	0.41	2.41	1.98	49	

ROTATION "D"

Plot No.	Area Acres	June 5	June 14	June 22	June 26		July 7	July 12	July 23	July 27	July 30	Aug. 6		Duty of Water	Rainfall April 1 to Harvest	Total Depth Rec'd	Total Depth Used in Growing the Crop	Yield per Acre	Remarks
82	0.121													0.00	0.41	0.41	0.70	3	Cut Aug. 2
81A	0.022				0.33									0.33	0.41	0.74	0.90	38	" 9
81B	0.025				0.33				0.34					0.67	0.41	1.08	0.94	46	" 9
81C	0.023			0.33				0.33		0.34				1.00	0.41	1.41	1.26	60	" 9
81D	0.052		0.33				0.33		0.34		0.33			1.33	0.41	1.74	1.10	55	" 9
81E	0.052	0.33			0.33			0.34		0.33		0.34		1.67	0.41	2.08	1.64	60	" 9
81G	0.050	0.33		0.33			0.34		0.33		0.33	0.34		2.00	0.41	2.41	2.17	63	" 9
81F	0.018				0.50				0.50					1.00	0.41	1.41	0.93	53	" 9
80A	0.037			0.50				0.50		0.50				1.50	0.41	1.91	1.35	58	" 9
80B	0.025		0.50				0.50		0.50		0.50			2.00	0.41	2.41	1.85	69	" 9

ALFALFA (A. B. LYMAN'S GRIMM) 1920

Schedule "E"

Plot No.	Area Acres	Irrigation — Date and Depth Applied in Acre-feet per acre: June 20	July 10	July 30	Aug. 20	Duty of Water	Rainfall April 1 to Harvest	Total Depth Rec'd	Total Depth Used in Growing the Crop	Yield of Seed in Bushels per Acre: Sown in Hills	Sown in Rows	Sown in Drills	Remarks
41A	0·037	....	....	....	....	0·00	0·41	0·41	0·75	(0·8)	(0·4)	(0·0)	
41B	0·037	0·25	....	....	....	0·25	0·41	0·66	0·88	(2·0)	(1·4)	(1·0)	
41C	0·037	0·25	0·25	....	....	0·50	0·41	0·91	1·08	(3·0)	(5·0)	(5·0)	
41D	0·037	0·25	0·25	0·25	....	0·75	0·41	1·16	1·24	4·78	8·33	8·90	
41E	0·037	0·25	0·25	0·25	0·25	1·00	0·41	1·41	1·62	3·12	4·87	6·26	

PEAS (PRUSSIAN BLUE) 1920

Rotation "E"

Schedule "F"

Plot No.	Area Acres	Irrigation — Date and depth applied in acre-feet per acre: June 7	June 16	June 23	June 26	June 28	July 1	July 8	July 14	July 17	July 23	July 28	Aug. 3	Aug. 8	Aug. 17	Duty of Water	Rainfall April 1 to Harvest	Total Depth Rec'd	Total Depth Used in Growing the Crop	Yield per Acre	Remarks (Cut)
30A	0.032															0.00	0.41	0.41	0.70	4.3	Aug. 14
26	0.240						0.33									0.33	0.41	0.74	0.95	24.0	" 14
25	0.240					0.33					0.34					0.67	0.41	1.08	1.25	47.5	" 27
24	0.234			0.33					0.33			0.34				1.00	0.41	1.41	1.62	49.2	" 27
23	0.240		0.33					0.33			0.34		0.33			1.33	0.41	1.74	2.00	52.7	" 27
22	0.232	0.33			0.33				0.34			0.33		0.34		1.67	0.41	2.08	2.29	55.0	Sept. 2
21A	0.101	0.33		0.33				0.34			0.33		0.33	0.34		2.00	0.41	2.41	2.44	60.7	" 2
21BE	0.053	0.33	0.33		0.34			0.33		0.33		0.34		0.33		2.33	0.41	2.74	2.26	56.0	" 2
21 BW	0.043	0.33	0.33		0.34			0.33		0.33		0.34		0.33	0.34	2.67	0.41	3.08	2.25	53.8	" 2
30	0.167					0.50					0.50					1.00	0.41	1.41	1.45	43.8	Aug. 28
29	0.195			0.50					0.50			0.50				1.50	0.41	1.91	2.20	58.0	" 28
28	0.213		0.50					0.50			0.50		0.50			2.00	0.41	2.41	2.53	68.0	Sept. 1

Schedule "G"

POTATOES (GOLD COIN) 1920

Rotation "A"

Plot No.	Area Acres	Irrigation — Date and Depth applied in Acre-feet per Acre: June 10	June 15	June 26	July 7	July 15	July 28	Aug. 7	Aug. 16	Aug. 23	Sept. 5	Sept. 15	Duty of Water	Rainfal April 1 to Harvest	Total Depth Rec'd	Total Depth Used in Growing the Crop	Yield per Acre	emarks
52A	0.024												0.00	0.41	0.41	1.09	24	Dug Sept. 20
B	0.024					0.17							0.17	0.41	0.58	1.22	72	
C	0.024				0.17			0.16					0.33	0.41	0.74	1.34	116	
D	0.040				0.17		0.17		0.16				0.50	0.41	0.91	1.50	150	
E	0.049			0.17		0.17		0.16		0.17			0.67	0.41	1.08	1.63	189	
53A	0.049		0.17		0.17		0.16		0.17		0.16		0.83	0.41	1.24	1.77	217	
B	0.049	0.17		0.17		0.16		0.17		0.17		0.16	1.00	0.41	1.41	1.89	167	
C	0.049			0.25				0.25					0.50	0.41	0.91	1.45	94	
D	0.035		0.25			0.25			0.25				0.75	0.41	1.16	1.77	151	
E	0.049	0.25			0.25			0.25			0.25		1.00	0.41	1.41	1.64	202	

Schedule "H"

POTATOES (EARLY OHIO), 1920

Rotation "C"

Plot No.	Area Acres	Irrigation — Date and Depth applied in Acre-feet per Acre: June 15	June 28	July 6	July 16	July 28	Aug. 7	Aug. 16	Aug. 25	Sept. 5	Sept. 15	Duty of Water	Rainfall April 1 to Harvest	Total Depth Rec'd	Total Depth Used in Growing the Crop	Yield per Acre	Remarks
83A	0.032											0.00	0.41	0.41	0.75	20	Dug Sept. 18
B	0.032				0.17							0.17	0.41	0.58	0.90	65	
C	0.032			0.17			0.16					0.33	0.41	0.74	1.05	100	
D	0.032			0.17		0.17		0.16				0.50	0.41	0.91	1.20	158	
E	0.032		0.17		0.17		0.16		0.17			0.67	0.41	1.08	1.35	175	
84A	0.030	0.17		0.17		0.16		0.17		0.16		0.83	0.41	1.24	1.50	185	
B	0.052	0.17	0.17		0.16		0.17		0.17		0.16	1.00	0.41	1.41	1.28	147	
C	0.052		0.25				0.25					0.50	0.41	0.91	0.89	171	
D	0.052	0.25			0.25			0.25				0.75	0.41	1.16	1.25	167	
E	0.050	0.25		0.25			0.25			0.25		1.00	0.41	1.41	1.24	158	

ALFALFA (A. B. LYMAN'S GRIMM), 1920

Rotation "A"

Schedule "I"

Plot No.	Area Acres	Irrigation — Date and Depth applied in Acre-feet per Acre: June 1	June 16	June 21	June 28	July 1	July 10	July 17	July 23	July 28	Aug. 3	Aug. 6	Aug. 16	Duty of Water	Rainfall April 1 to Harvest	Total Depth Rec'd	Total Depth Used in Growing the Crop	Yield in Tons per Acre	Remarks: Cuttings 1 July 8, 2 August 13, 3 September 14
44A	0.005													0.00	0.41	0.41		0.30	
B	0.028		0.33											0.33	0.41	0.74	1.63	4.33	
C	0.027		0.33					0.34						0.67	0.41	1.08	1.90	3.82	
D	0.028	0.33			0.33				0.34					1.00	0.41	1.41	2.10	3.96	
E	0.027	0.33		0.34			0.33				0.33			1.33	0.41	1.74	2.33	6.00	
45A	0.028	0.33	0.33			0.34		0.33			0.33			1.67	0.41	2.08	2.53	6.48	
B	0.029	0.33	0.33			0.34		0.33			0.33		0.34	2.00	0.41	2.41	2.79	6.08	
C	0.030	0.50	0.50			0.50		0.50			0.50			2.50	0.41	2.91	3.02	5.40	
D	0.032	0.50	0.50			0.50		0.50			0.50		0.50	3.00	0.41	3.41	3.08	5.98	
E	0.032	0.50	0.50			0.50		0.50		0.50		0.50	0.50	3.50	0.41	3.91	3.08	6.48	

HAY GRASSES, 1920

Rotation "C"

Schedule "J"

Plot No.	Area Acres	Irrigation — Date and Depth applied in acre-feet per Acre: June 2	June 10	June 16	June 22	June 25	June 30	July 6	July 12	July 16	Aug.	Duty of Water	Rainfall April 1 to Harvest	Total Depth Rec'd	Total Depth Used in Growing the Crop	Yield in Tons per Acre	Remarks
85A	0.032	0.33										0.33	0.41	0.74	0.59	0.80	Cut July 26
B	0.030	0.33			0.34							0.67	0.41	1.08	0.98	1.23	
C	0.031	0.33		0.33			0.34					1.00	0.41	1.41	1.38	1.61	
D	0.031	0.33		0.33		0.34		0.33				1.33	0.41	1.74	1.80	1.75	
E	0.027	0.33	0.33		0.34		0.33		0.34			1.67	0.41	2.08	1.98	1.72	
86A	0.030	0.33	0.33		0.34		0.33		0.33	0.34		2.00	0.41	2.41	2.14	1.75	
B	0.029	0.33										0.33	0.41	0.74	1.06	1.33	
C	0.029	0.50			0.50							1.00	0.41	1.41	1.79	1.40	
D	0.030	0.50		0.50			0.50					1.50	0.41	1.91	1.89	1.58	
E	0.031	0.50		0.50			0.50			0.50		2.00	0.41	2.41	1.96	1.74	

SUGAR BEETS (KLEIN WANZLEBEN), 1920

Rotation "B"

Schedule "K"

Plot No.	Area Acres	Irrigation — Date and Depth applied in Acre-feet per Acre: June 12	July 22	Aug. 6	Aug. 25	Sept. 8	Duty of Water	Rainfall April 1 to Harvest	Total Depth Rec'd	Total Depth Used Growing the Crop	Yield in Tons per Acre	Remarks
70A	0.017	0.33	....	....	....	....	0.33	0.41	0.74	1.12	1.8	Dug Sept. 23
B	0.031	0.33	0.33	....	....	....	0.67	0.41	1.08	1.25	8.9	
C	0.026	0.33	0.33	0.34	....	....	1.00	0.41	1.41	1.40	12.5	
D	0.026	0.33	0.33	0.34	0.33	....	1.33	0.41	1.74	1.55	15.7	
E	0.028	0.33	0.33	0.34	0.33	0.34	1.67	0.41	2.08	1.87	16.0	

CORN (SQUAW), 1920

Rotation "B"

Schedule "L"

Plot No.	Area Acres	Irrigation — Date and Depth applied in Acre-feet per Acre: June 12	July 22	August 6	August 16	August 25	Duty of Water	Rainfall April 1 to Harvest	Total Depth Rec'd	Total Depth Used Growing the Crop	Yield in Tons per Acre	Remarks
71A	0.030	0.33	....	....	....	....	0.33	0.41	0.74	....	1.23	Harvested
B	0.030	0.33	0.33	....	....	....	0.67	0.41	1.08	....	2.07	between
C	0.030	0.33	0.33	0.34	....	....	1.00	0.41	1.41	....	2.22	August 10
D	0.030	0.33	0.33	0.34	0.33	....	1.33	0.41	1.74	....	2.90	and Sept. 22
E	0.030	0.33	0.33	0.34	0.33	0.34	1.67	0.41	2.08	....	2.05	

PEAS (CANADA BLUE), 1920

SCHEDULE "M"

Plot No.	Area Acres	Irrigation — Date and Depth Applied in Acre-feet per Acre: June 1	June 5	June 10	June 15	June 20	June 25	June 30	July 10	July 15	July 20	July 25	July 30	Aug.	Duty of Water	Rainfall April 1 to Harvest	Total Depth Rec'd	Total Depth Used to Grow the Crop	Yield per Acre in Bushels	Remarks
19	0.25														0.00	0.44	0.44	0.55	11.5	
21	0.25					0.33									0.33	0.44	0.77	1.10	18.8	
22	0.25				0.33				0.34						0.67	0.44	1.11	1.36	23.8	
23	0.25			0.33				0.33		0.34					1.00	0.44	1.44	1.55	23.2	
24	0.25		0.33				0.33		0.34		0.33				1.33	0.44	1.77	1.95	25.2	
25	0.25	0.33			0.33			0.34		0.33		0.34			1.67	0.44	2.11	2.30	28.5	
26	0.25	0.33		0.33			0.34		0.33		0.33		0.34		2.00	0.44	2.44	2.47	34.5	

WHEAT (MARQUIS), 1920

SCHEDULE "N"

		1	5	10	15	20	25	30	10	15	20	25	30							
43	0.25														0.00	0.44	0.44	0.59	6.0	
45	0.25					0.33									0.33	0.44	0.77	0.92	26.4	
46	0.25				0.33				0.34						0.67	0.44	1.11	1.32	33.2	
47	0.336			0.33				0.33		0.34					1.00	0.44	1.44	1.67	39.2	
48	0.281		0.33				0.33		0.34		0.33				1.33	0.44	1.77	1.97	42.7	
49	0.226	0.33			0.33			0.34		0.33		0.34			1.67	0.44	2.11	2.37	50.3	
50	0.186	0.33		0.33			0.34		0.33		0.33		0.34		2.00	0.44	2.44	2.39	40.3	

DUTY OF WATER PLOTS, RONALANE, ALBERTA, 1920

The duty of water investigations at Ronalane were carried out along practically the same lines as adopted for the 1919 work, with the exception of the depth applied per irrigation to the potato and sugar-beet series, which was changed from four inches to three inches.

The climatology of the growing season was similar to that prevailing at the Brooks station; being characterized by a late, cold spring, hot and very dry summer, and violent destructive winds in August. Table No. 10 gives the mean monthly temperatures and precipitation in comparison with those prevailing at Brooks, Coaldale and Strathmore.

All field-work in connection with the plots was under the supervision of Mr. A. Hildenbrand, who succeeds Mr. S. Hansen as manager of irrigated farms for the Canada Land and Irrigation Company.

The duty of water data obtained as a result of last summer's work are, for the majority of the crops, very good. The data secured for field peas are unreliable, the yields given in the table being only an estimate as submitted by the farm superintendent. Heavy winds in August shelled out the crop before it could be threshed; therefore the only information of value which can be drawn from the pea experiment is that the optimum depth of water received is not less than 2 feet. Plots Nos. 5, 7 and 9 in the alfalfa series gave yields considerably less than is consistent with the depth of water which they received. This reduction in yield was caused by some of the irrigations not having been applied on their scheduled dates. By consulting table No. 6, which gives the data for the alfalfa series, it will be noted that in the irrigation of plot No. 5, forty days elapsed between irrigations, when the scheduled interval was but from twenty to twenty-five days. This had the effect of materially reducing the yield of the plot, as it forced the plants to go too long without an adequate supply of moisture, especially through the hottest part of the season when they would have been making their most vigorous growth had they received the required amount of water. The plot actually received the required amount of water but the irrigations were bunched too much at both ends of the irrigating season. The yields from plots Nos. 7 and 9 also show evidence of this same treatment.

In the alfalfa series the maximum yield, 3·44 tons per acre, was produced with a total depth of water (irrigation plus precipitation) of 2·11 feet, of which 1·67 feet were applied in five four-inch irrigations. Additional irrigations reduced the yield. The dry plot produced 0·2 ton per acre.

The maximum yield of wheat, 50·3 bushels per acre, was produced with a total depth of 2·11 feet of water. An increase in depth reduced the yield. The dry plot produced 6 bushels per acre.

The maximum yield of oats, 75·3 bushels per acre, was produced with a total depth of 2·11 feet of water. An increase in depth reduced the yield. The dry plot produced 10·5 bushels per acre.

The maximum yield of barley, 50·8 bushels per acre, was produced with a total depth of 2·11 feet of water. An increase in depth reduced the yield. The dry plot produced 9·2 bushels per acre.

The maximum yield of potatoes, 315·4 bushels per acre, was produced with a total depth of 1·70 feet of water. An increase in depth decreased the yield. The dry plot produced 10 bushels per acre.

The maximum yield of sugar-beets, 15·4 tons per acre, was produced with a total depth of 1·70 feet of water. An increase in depth decreased the yield. The dry plot produced 4·1 tons.

OATS (ABUNDANCE), 1920

SCHEDULE "O"

Plot No.	Area Acres	Irrigation — Date and Depth Applied in Acre-feet per Acre: June 1	June 5	June 10	June 15	June 20	June 25	June 30	July 10	July 15	July 20	July 25	July 30	Aug.	Duty of Water	Rainfall April 1 to Harvest	Total Depth Rec'd	Total Depth Used in Growing the Crop	Yield per Acre	Remarks
35	0.25														0.00	0.44	0.44	0.70	10.5	
37	0.25					0.33									0.33	0.44	0.77	1.01	44.0	
38	0.25				0.33				0.34						0.67	0.44	1.11	1.32	50.6	
39	0.25			0.33											1.00	0.44	1.44	1.68	56.4	
40	0.25		0.33				0.33		0.34		0.33				1.33	0.44	1.77	2.00	59.6	
41	0.186	0.33			0.33			0.34		0.33		0.34			1.67	0.44	2.11	2.37	75.3	
42	0.131	0.33		0.33			0.34		0.33		0.33		0.34		2.00	0.44	2.44	2.54	71.0	

BARLEY (BARK'S EXCELSIOR), 1920

SCHEDULE "P"

		1	5	10	15	20	25	30	10	15	20	25	30							
27	0.25														0.00	0.44	0.44	0.58	9.2	
29	0.25					0.33									0.33	0.44	0.77	1.03	32.8	
30	0.25				0.33				0.34						0.67	0.44	1.11	1.49	38.4	
31	0.25			0.33				0.33		0.34					1.00	0.44	1.44	1.62	40.4	
32	0.25		0.33				0.33		0.34		0.33				1.33	0.44	1.77	2.10	47.6	
33	0.25	0.33			0.33			0.34		0.33		0.34			1.67	0.44	2.11	2.26	50.8	
34	0.25	0.33		0.33			0.34		0.33		0.33		0.34		2.00	0.44	2.44	2.65	47.6	

POTATOES (GOLD COIN), 1920

SCHEDULE "Q"

Plot No.	Area Acres	Irrigation — Date and Depth Applied in Acre-feet per Acre: June 1	June 5	June 15	June 25	July 5	July 15	July 25	August 10	August 15	August 25	Sept. 5	Duty of Water	Rainfall April 1 to Harvest	Total Depth Rec'd	Total Depth Used in Growing the Crop	Yield per Acre	Remarks
11	0.25												0.00	0.45	0.45	0.45	10.0	
13	0.25					0.25							0.25	0.45	0.70	0.72	104.0	
14	0.25				0.25			0.25					0.50	0.45	0.95	0.99	108.0	
15	0.25				0.25		0.25		0.25				0.75	0.45	1.20	1.28	146.0	
16	0.25			0.25		0.25		0.25		0.25			1.00	0.45	1.45	1.53	217.2	
17	0.25		0.25		0.25		0.25		0.25		0.25		1.25	0.45	1.70	1.73	315.4	
18	0.25	0.25		0.25		0.25		0.25		0.25		0.25	1.50	0.45	1.95	1.85	286.2	

ALFALFA (A. B. LYMAN'S), 1920

SCHEDULE "R"

Plot No.	Area Acres	Irrigation — Date and Depth Applied in Acre-feet per Acre: May 25	June 1	June 5	June 10	June 15	June 20	June 25	June 30	July 20	July 30	Aug. 12	Duty of Water	Rainfall April 1 to Harvest	Total Depth Rec'd	Total Depth Used in Growing the Crop	Yield in Tons per Acre	Remarks
1	0.25												0.00	0.44	0.44		0.20	
2	0.25		0.33										0.33	0.44	0.77		0.70	
3	0.25	0.33							0.34				0.67	0.44	1.11		1.74	
4	0.25	0.33					0.33			0.34			1.00	0.44	1.44		2.87	
5	0.25	0.33			0.33					0.34	0.33		1.33	0.44	1.77		2.65	Too long bet. 2nd and 3rd irr.
6	0 25	0.33			0.33			0.34		0.33		0.34	1.67	0.44	2.11		3.44	
7	0.25	0.33	0.33				0.34			0.33	0.33	0.34	2.00	0.44	2.44		2.97	
8	0.25	0.50		0.50				0.50		0.50		0.50	2.50	0.44	2.94		3.39	
9	0.25	0.50	0.50			0.50				0.50	0.50	0.50	3.00	0.44	3.44		2.98	Too long bet. 3rd and 4th irr.
10	0.25	0.50	0.50			0.50			0.50	0.50	0.50	0.50	3.50	0.44	3.94		3.03	

SUGAR BEETS (KLEIN WANZLEBER), 1920

SCHEDULE "S"

Plot No.	Area Acres	Irrigation — Date and Depth Applied in Acre-feet per Acre: June 1	June 5	June 15	June 25	July 5	July 15	July 25	August 10	August 15	August 25	Sept. 5	Duty of Water	Rainfall April 1 to Harvest	Total Depth Rec'd	Total Depth Used to Grow the Crop	Yield in Tons	Remarks
51	0.106												0.00	0.45	0.45		4.1	
52	0.106					0.25							0.25	0.45	0.70		8.0	
53	0.106				0.25			0.25					0.50	0.45	0.95		10.2	
54	0.159				0.25		0.25		0.25				0.75	0.45	1.20		9.4	
56	0.106			0.25		0.25		0.25		0.25			1.00	0.45	1.45		12.2	
57	0.106		0.25		0.25		0.25		0.25		0.25		1.25	0.45	1.70		15.4	
58	0.159	0.25		0.25		0.25		0.25		0.25		0.25	1.50	0.45	1.95		12.1	

SUMMARY OF RESULTS AT RONALANE SHOWING THE TOTAL DEPTH OF WATER PRODUCING THE MAXIMUM YIELD IN EACH YEAR

SCHEDULE "T"

Crop	1915		1916		1917		1918		1919		1920		Average	
	Yield	Depth	Yield	Depth	Yield	Depth	Yield	Depth	Yield	Depth	Yield	Depth	Yield	Depth
Alfalfa	4·04	1·94	3·82	3·27	3·13	1·68	2·46	1·33	3·11	2·17	3·44	2·11	3·50	2·08
Wheat	48·00	1·55	48·00	1·82	50·00	1·86	38·00	2·32	40·00	1·80	50·00	2·11	46·00	1·91
Oats	108·00	3·00	79·00	1·82	106·00	1·36	101·00	3·32	77·00	1·50	75·00	2·11	91·00	2·18
Barley	48·00	1·41	56·00	1·77	55·00	1·35	84·00	2·01	56·00	1·83	51·00	2·11	58·00	1·75
Peas	25·00	1·78	53·00	2·90	61·00	1·35	57·00	2·86	34·00	2·50	34·00	2·44	44·00	2·30
Sugar-Beets	10·00	1·55	11·00	2·24	17·00	1·16	....	....	....	....	15·00	1·70	13·00	1·66
Potatoes	408·00	2·03	294·00	1·82	....	....	471·00	2·36	366·00	2·26	315·00	1·70	371·00	2·03

DUTY OF WATER, COALDALE, ALBERTA, 1920

No departure of any importance was made during the past season from the general methods used in obtaining duty of water data in this district during 1919.

April and May were colder than usual with a heavy snow in early May which provided sufficient moisture to insure the germination of grain crops.

Heavy winds prevailed during the latter part of May and the first part of June. They were of such severity that considerable areas of seeded grain were blown out to such an extent as to necessitate re-seeding. This damage was most extensive over the non-irrigated areas. One-fourth of the area of field No. 307 was covered to such depth by drifting soil from an adjoining ploughed field as to cause the complete destruction of the timothy under this sand-covered portion of the field. Heavy southwest winds continued to blow throughout the season, causing a material reduction in crop yields by their withering and shattering effects, and throughout the harvesting and threshing periods occasioned much delay in properly handling the crops.

The grain crops on fields Nos. 325 and 326 lying north of Coaldale were damaged to an extent of from fifty to seventy-five per cent by a local hailstorm.

Many farmers, believing that the spring rains had provided ample moisture to see their crops through the early part of the season, and not anticipating the damaging winds, postponed the date of their first irrigation until it was too late to effectively apply the water to save the crops from the burning effects of the winds.

The mean temperature, April to September, was 54.7° as compared with 56.7° for 1919. The evaporation for the same period was 32.94 inches as compared with 37.9 inches for 1919.

The schedule immediately following gives a summary of the duty of water data obtained during the season. All alfalfa fields, except No. 329, received two irrigations. No field yielded more than two cuttings. Plot No. 324 produced the heaviest first cutting, 3.58 tons per acre, and also produced the heaviest total yield, 5.07 tons per acre, for the two cuttings. This yield was produced with a total depth of 2.84 feet of water, 1.01 feet in depth being applied at the first irrigation. It is doubtful whether such an excessive depth per single application can be utilized to advantage by the crop, and it is therefore logical to assume that the same yield could have been produced with 0.25 foot less total depth of water.

For the thirteen fields in forage crops during 1920, the average total depth of water received was 2.08 feet, and for the five fields in other crops, principally grains, the average total depth of water received was 1.51 feet.

For all the tracts the average total depth of water received was 1.92 feet.

SCHEDULE 'U'

TABLE SHOWING TOTAL DEPTH OF WATER USED COALDALE TRACTS, 1913 TO 1920

Crop	1913			1914			1915			1916			1917		
	Duty	Precipitation	Total Water Received	Duty	Precipitation	Total Water Received	Duty	Precipitation	Total Water Received	Duty	Precipitation	Total Water Received	Duty	Precipitation	Total Water Received
Alfalfa	1·70	0·98	2·68	2·11	0·57	2·68	0·68	1·32	2·00	0·41	1·56	1·97	1·31	0·68	1·99
Timothy	0·85	0·98	1·83	......	......	......	1·28	1·32	2·60	0·33	1·56	1·89	1·48	0·71	2·19
Wheat	0·74	0·98	1·72	......	......	......	0·22	1·32	1·54	0·00	1·73	1·73	0·78	0·41	1·19
Oats	......	......	......	1·49	0·57	2·06	0·00	1·32	1·32	0·00	1·73	1·73	......	......	......
Barley	......	......	......	1·25	0·57	1·82	0·00	1·32	1·32	0·00	1·56	1·56	......	......	......
Average	1·15	0·98	2·13	1·84	0·57	2·41	0·57	1·32	1·89	0·28	1·56	1·84	1·18	0·65	1·83

Crop	1918			1919			1920			Average 1913 to 1920		
	Duty	Precipitation	Total Water Received	Duty	Precipitation	Total Water Received	Duty	Precipitation	Total Water Received	Duty	Precipitation	Total Water Received
Alfalfa	2·00	0·31	2·31	1·56	0·47	2·13	1·31	0·81	2·12	1·39	0·79	2·18
Timothy	1·30	0·30	1·60	1·25	0·25	1·50	0·80	0·78	1·58	1·12	0·77	1·89
Wheat	1·16	0·29	1·45	1·18	0·38	1·56	0·47	0·81	1·28	0·71	0·82	1·53
Oats	1·04	0·28	1·32	1·15	0·42	1·57	0·55	0·80	1·35	0·76	0·82	1·58
Barley	......	......	......	......	......	......	......	......	......	0·42	1·19	1·61
Average	1·70	0·30	2·00	1·33	0·43	1·76	1·11	0·81	1·92	1·14	0·83	1·97

The preceding schedule shows the average total depth of water received (irrigation plus precipitation) for the Coaldale plots from 1913 to 1920. The average total depth of water received for the grain crops is 1.57 feet. The average duty of water for the same eight years for grains is 0.63 foot. For the alfalfa and grasses the average total depth received for eight years is 2.03 feet and the average duty of water is 1.25 feet. For all plots, alfalfa, grasses and grains, the average total depth received for eight years is 1.97 feet. The average duty of water is 1.14 feet.

DISCUSSION OF SUMMARIZED DATA

The duty of water for any locality will vary from year to year, principally in accordance with the amount and seasonable distribution of the precipitation, and to a lesser extent as influenced by temperature and the conditions of soil and subsoil; therefore, in order that the water requirements of crops may readily be compared, from one year to another, or between different localities, it is best to consider that crops annually receive a certain amount of water—precipitation plus irrigation—and designate this amount as the "Total Depth Received."

The next table is inserted to show the climatic conditions prevailing during the years 1914 to 1920 inclusive, at the four stations from which data have been taken in writing the general discussion on duty of water.

—	Prcipitation							Temperature						
	1914	1915	1916	1917	1918	1919	1920	1914	1915	1916	1917	1918	1919	1920
	Feet	Feet	Feet	Feet	Feet	Feet	Feet	°F.	°F.	°F.	°F.	°F.	°F.	°F.
Strathmore	0·17	1·44	1·33	0·85	0·48	1·09	0·74	52·4	52·6	50·6	52·0	52·8	52·9	51·0
Ronalane	0·38	0·93	1·32	0·50	0·38	0·57	0·45	59·4	57·1	55·2	55·8	56·8	58·4	56·0
Coaldale	0·57	1·32	1·56	0·72	0·37	0·64	0·84	55·9	55·4	54·5	55·4	55·9	56·7	54·7
Brooks	......	......	......	0·57	0·32	0·70	0·41	55·6	56·3	......	56·3	58·0	57·5	55·6

DUTY OF WATER TRACTS, COALDALE, ALBERTA, 1920

SCHEDULE V

Plot No.	Acres	Irrigation					Acre-feet per Acre								Yield in Tons		Crop	Remarks
		No.	Began	Ended	Duration in Hours	Average Head C.F.S.	Supplied	Wasted	Used	Used per Acre	Duty	Rainfall April 1 to Harvest	Total Depth Rec'd	Total Depth Used	Per Cutting	Per Acre		
302	30.00	1	July 3	July 8	69	2.00	11.42	0.61	10.81	0.36					1.33			
		2	Aug. 9	Aug. 12	81	3.16	21.16	6.81	14.35	0.48	0.84	0.81	1.65	1.88	1.13	2.46	Alfalfa	Seeded 1909
304	42.00	1	June 10	June 18	158	1.81	23.64	0.52	23.12	0.55					3.01			
		2	Aug. 12	Aug. 21	224	1.18	21.86		21.86	0.52	1.07	0.79	1.86	1.50	1.38	4.39	Alfalfa	" 1907
305	23.50	1	June 20	June 26	144	2.59	30.82	10.95	19.87	0.84					2.66			
		2	Aug. 11	Aug. 17	142	2.90	34.04	9.99	24.05	1.02	1.86	0.81	2.67	2.26	2.00	4.66	Alfalfa	" 1912
306	14.00	1	June 16	June 20	96	3.15	25.01	12.87	12.14	0.87					2.46			
		2	Aug. 6	Aug. 9	72	2.21	13.15	7.66	5.49	0.39	1.26	0.81	2.07	2.23	1.54	4.00	Alfalfa	" 1914
310	19.70	1	June 9	June 11	56	2.71	12.54		12.54	0.64					1.92			
		2	Aug. 9	Aug. 11	59	2.30	11.21		11.21	0.57	1.21	0.83	2.04	2.66	1.00	2.92	Alfalfa	" 1914
312	50.00	1	June 12	June 17	130	3.12	33.51		33.51	0.67					2.08			
		2	Aug. 7	Aug. 14	168	2.56	35.59		35.59	0.71	1.38	0.81	2.19	2.29	1.34	3.42	Alfalfa	" 1914
313	50.00	1	June 19	June 25	192	2.02	23.72	0.99	22.73	0.45					3.25			
		2	Aug. 18	Aug. 26	111	2.39	37.78	2.97	34.81	0.70	1.15	0.83	1.98	2.08	1.30	4.55	Alfalfa	" 1914
314	35.09	1	June 16	June 20	110	2.40	21.81	1.05	20.76	0.59					3.03			
		2	Aug. 6	Aug. 13	171	4.01	56.76		56.76	1.62	2.21	0.83	3.04	2.70	1.93	4.96	Alfalfa	" 1914
315	50.00	1	June 14	June 19	116	1.69	16.21		16.21	0.32					2.03			
		2	July 22	Aug. 2	258	3.10	66.02		66.02	1.32	1.64	0.81	2.45	2.50	1.70	3.73	Alfalfa	" 1914
324	32.73	1	June 11	June 23	293	1.48	35.85	2.71	33.14	1.01					3.58			
		2	Aug. 11	Aug. 20	216	1.32	23.56		23.56	0.72	1.73	0.81	2.54	2.84	1.49	5.07	Alfalfa	" 1914
329	11.00	1	Aug. 9	Aug. 12	68	1.26	7.06		7.06	0.64	0.64	0.81	1.45	0.81	1.22			
															1.75	2.97	Alfalfa	" 1914
334	16.40	1	June 24	June 27	72	1.42	8.45	1.47	6.98	0.42					1.79			
		2	July 31	Aug. 4	98	0.59	4.76		4.76	0.29	0.71	0.79	1.50	1.40	1.00	2.79	Alfalfa	" 1914
303	22.50	1	June 1	June 10	203	1.32	22.22	4.18	18.04	0.80	0.80	0.78	1.58	1.75	1.74	1.74	Timothy	" 1914
			Average for forage crops								1.27	0.81	2.08	2.07				

DUTY OF WATER TRACTS, COALDALE, ALBERTA, 1920

SCHEDULE "W"

Plot No.	Acres	Irrigation No.	Irrigation Began	Irrigation Ended	Irrigation Duration in Hours	Irrigation Average Head in C.F.S.	Acre-feet per Acre Supplied	Acre-feet per Acre Wasted	Acre-feet per Acre Used	Acre-feet per Acre Used per Acre	Acre-feet per Acre Duty	Acre-feet per Acre Rainfall April 1 to Harvest	Acre-feet per Acre Total Depth Rec'd	Acre-feet per Acre Total Depth Used	Yield Bushels per Acre	Crop	Remarks
331	3.2	1	Aug. 11	Aug. 12	32	1.70	4.51	0.00	4.51	1.41	1.41	0.83	2.24	2.30	110.6	Potatoes	
322	13.3	1	June 27	June 30	64	1.56	8.25	0.00	8.25	0.62	0.62	0.79	1.41	1.52	55.6	Oats	
332	5.8	1	June 30	July 1	23	1.43	2.72	0.00	2.72	0.47	0.47	0.81	1.28	1.20	30.0	Oats	
330	8.6	1	July 8	July 9	25	2.23	4.60	0.00	4.60	0.54	0.54	0.81	1.35	0.52	33.0	Oats	
333	12.7	1	July 1	July 3	54	1.34	5.97	0.00	5.97	0.47	0.47	0.81	1.28	1.10	40.0	Wheat	
			Average for Grain and Root Tracts				....	....	....	0.70	0.70	0.81	1.51	1.33	-		
			Average for all Tracts for 1920				....	....	....	0.68	1.11	0.81	1.92	1.85			

The following table is inserted for purposes of comparison and shows the average climatic conditions which prevailed during the seven years as compared with long term averages. In both tables the data cover the period April to September, inclusive.

—	Precipitation		Temperature	
	1914–1920	Long term	1914–1920	Long term
	Feet	Feet	°F.	°F.
Calgary	0·78	1·01	54·44	52·51
Medicine Hat	0·71	0·77	59·33	59·07
Lethbridge	0·83	0·97	54·78	55·64

Calgary—Index for Strathmore—long term records 1885–1920; Medicine Hat—Index for Ronalane and Brooks—long term records 1884–1920; Lethbridge—Index for Coaldale—long term records 1903–1920.

The small chart below indicates the different soil conditions at Strathmore, Ronalane, Coaldale and Brooks.

DIAGRAM SHOWING TYPICAL SOILS

—	Strathmore	Ronalane	Coaldale	Brooks
	Sandy Soil	Fine Sandy Loam	Clay Loam	Fine Sandy Loam
First Foot	Fine Sandy Soil to depth		Light Clay Loam	Very uniform
Second Foot	varying from	Sandy Loam	very uniform	soil. Very fine sand
Third Foot	3 to 7 feet		has no	and silt Light
Fourth Foot	Heavy clay and gumbo	Sand and	impervious stratum	gravel at 12 to 14
Fifth Foot	subsoil Very	Gravel		feet depth
Sixth Foot	impervious			

The following table gives a summary of the data collected from the Coaldale, Ronalane and Brooks stations during the period 1913 to 1920 inclusive. It is not the intention to set forth these figures as representing the exact depths of water required for the various crops, but rather as showing the results of investigations to date. The column headed "Yield" is inserted as a useful index to the crops produced at these three stations. The column headed "Depth" shows in feet the total depth of water received (irrigation plus precipitation).

The *average depth* shown is the average of the depths at the different stations weighted according to the number of years during which records have been taken at each place. The column marked "Average Depth" shows the average for Coaldale, Ronalane and Brooks.

The data at Coaldale are based on results gained by average farmers irrigating their own fields and cover a period of eight years—the yields at Coaldale have been omitted because they would not be comparable with the results obtained at the other places.

The results at Ronalane are based on plot work carried on consistently for six years. The results at Brooks are based on accurate and consistent plot work covering a period of three years. For Ronalane and Brooks the figures shown represent the average, at each place, of the total depths of water producing the maximum crop yield in each year. For Coaldale the figures represent the average for ordinary crops in each year.

Crop	Coaldale		Ronalane		Brooks		Average
	Yield	Depth	Yield	Depth	Yield	Depth	Depth
Wheat	....	1·53	45·9	1·91	46·5	2·03	1·77
Oats	....	1·58	91·4	2·15	94·4	1·82	1·86
Barley	....	1·61	58·5	1·74	57·3	1·98	1·77
Peas	....	....	44·0	2·31	52·7	2·29	2·30
Potatoes	....	0·83	371·0	2·03	298·7	1·72	1·79
Flax	....	....	....	....	24·4	1·95	1·95
Alfalfa seed	....	....	....	....	10·7	1·23	1·23
Alfalfa	....	2·18	3·33	2·08	6·48	2·08	2·19
Grasses	....	1·89	....	....	1·66	1·66	1·66
Sugar beets	....	....	1·35	1·66	16·2	1·82	1·82

The average depth noted in the above table indicates quite clearly the total depths of water required for the crops listed, when grown in that part of Alberta lying south of township twenty-eight, and exclusive of that strip of country lying immediately east of the foothills.

Assuming, as in previous reports, that eventually all irrigated farms will be seeded down, one-half to alfalfa and one-half to common grains, we have:—

Average depth for wheat, oats and barley	1.80	feet
Average depth for alfalfa	2.19	"
Then, total required for entire farm unit	2.00	"

With the legal duty of water at 1.50 feet, under this condition we would need to rely on the seasonal precipitation to make up the additional 0.50 foot.

The mean summer precipitation at Ronalane for the past four dry years, 1917 to 1920 inclusive	.47	foot
The mean summer precipitation at Brooks (same period)	.50	"
The mean summer precipitation at Coaldale (same period)	.64	"
Mean of three stations	.54	"

We find, therefore, that even during the past four dry seasons in southern Alberta we have had enough precipitation when added to the legal duty, to meet the above indicated possible duty.

SCHEDULE "X"

TABLE SHOWING COMPARISONS BETWEEN COALDALE, RONALANE AND BROOKS FOR TEMPERATURE, PRECIPITATION AND EVAPORATION

		NW. 25-8-20						NW. 5-13-12						SE. 6-19-14					
		Coaldale El. 2828.1						Ronalane El. 2330						Brooks El. 2455					
		1915	1916	1917	1918	1919	1920	1915	1916	1917	1918	1919	1920	1915	1916	1917	1918	1919	1920
Evaporation.	Apr.	5.68	1.51	2.55	3.20	6.59	3.31	....	....	....	....	....	....	....	....	....	5.68	2.47	1.05
	May	4.28	5.12	4.83	6.76	5.20	5.68	....	....	....	....	....	....	....	....	....	8.47	6.07	4.28
	June	2.26	4.68	5.78	7.88	7.30	6.47	....	....	....	....	....	....	....	....	....	8.50	7.33	5.73
	July	4.38	6.20	9.20	7.68	8.12	6.92	....	....	....	....	....	....	....	....	....	9.57	7.15	5.15
	Aug.	4.97	4.70	5.23	6.79	6.91	5.76	....	....	....	....	....	....	....	....	....	6.80	5.21	5.65
	Sept.	2.93	3.59	4.35	3.76	3.81	4.80	....	....	....	....	....	....	....	....	....	3.84	3.21	4.12
	Sums	24.50	25.80	31.94	36.07	37.93	32.94	....	....	....	....	....	....	....	....	....	42.86	31.44	25.98
Precipitation.	Apr.	0.00	0.26	0.70	0.15	0.53	3.54	0.09	0.14	0.84	0.21	2.34	0.90	....	....	0.58	0.00	1.41	1.16
	May	2.99	4.12	0.86	1.03	1.86	1.59	1.69	2.33	0.76	0.65	1.62	1.54	....	....	1.01	0.42	1.02	0.88
	June	5.31	3.82	2.11	0.65	0.66	1.09	4.15	4.32	1.29	1.22	0.37	0.66	5.41	2.27	0.89	0.54	0.40	1.52
	July	5.15	2.47	0.29	0.93	1.27	3.21	3.26	4.24	0.24	1.37	0.89	2.22	1.55	2.61	1.06	1.39	1.46	1.41
	Aug.	0.28	3.25	1.88	1.23	1.20	0.29	0.75	1.68	1.34	0.92	0.77	0.00	2.07	1.80	2.45	1.15	2.40	0.00
	Sept.	2.11	4.79	2.82	0.41	2.14	0.31	1.29	3.14	1.53	0.22	0.83	0.03	0.65	2.45	0.82	0.31	1.77	0.00
	Sums	15.84	18.71	8.66	4.40	7.66	10.03	11.23	15.85	6.00	4.59	6.82	5.35	....	....	6.81	3.81	8.46	4.97
Temperatures.	Apr.	50.0	44.2	39.2	42.8	45.4	31.1	51.4	43.9	37.7	42.2	45.5	33.6	48.2	43.0	39.0	46.0	43.8	34.6
	May	51.1	48.6	49.7	44.0	49.0	47.6	53.0	48.7	51.6	49.8	53.6	50.4	50.0	47.0	52.0	52.0	53.1	50.3
	June	54.7	56.4	56.4	63.0	58.3	57.0	56.4	57.6	57.8	64.1	63.1	59.7	56.4	58.0	58.3	65.0	62.4	59.4
	July	59.3	63.3	68.5	64.3	65.9	69.0	61.2	65.8	69.9	65.0	67.3	69.5	62.0	66.0	70.5	67.5	66.3	69.0
	Aug.	67.2	60.8	63.5	63.5	66.7	68.1	69.2	62.1	62.6	64.4	66.6	65.8	70.0	62.0	63.9	64.2	64.5	64.6
	Sept.	50.1	53.6	55.1	57.4	54.8	55.4	51.5	53.3	55.1	55.0	54.6	56.9	51.0	52.0	54.3	53.2	54.8	55.5
	Average	55.4	54.5	55.4	55.9	56.7	54.7	57.1	55.2	55.8	56.8	58.4	56.0	56.3	54.6	56.3	58.0	57.5	55.6

Average for six years

	Temperature	Precipitation	Evaporation
Coaldale	55.5°	10.88″	31.53″
Ronalane	56.5°	8.31″	
Brooks	56.5°		

SCHEDULE "Y"

TABLE SHOWING TEMPERATURES, PRECIPITATION, AND EVAPORATION AT STRATHMORE, ALBERTA
NE. 11-24-25

		Strathmore El. 3190					
		1915	1916	1917	1918	1919	1920
Evaporation	Apr.	4·22	2·59	2·09	2·88	4·15	2·05
	May	4·73	3·46	3·70	4·58	6·42	3·00
	June	4·33	4·59	4·60	5·83	6·42	4·20
	July	6·47	4·84	5·88	6·13	5·46	4·47
	Aug	4·25	3·16	3·66	4·01	3·65	4·47
	Sept	2·27	2·66	2·27	2·62	1·64	3·67
	Sums	26·27	21·30	22·20	26·05	27·74	21·86
Precipitation	Apr.	0·11	0·44	0·56	0·39	1·45	2·11
	May	3·42	4·51	3·26	1·08	2·26	1·78
	June	4·77	2·02	2·30	0·22	1·10	1·72
	July	4·89	3·42	0·51	1·10	1·56	2·87
	Aug	1·48	3·13	2·48	2·10	3·46	0·27
	Sept	2·56	2·60	1·05	0·82	3·26	0·08
	Sums	17·23	16·00	10·16	5·71	13·09	8·83
Temperatures	Apr.	46·6	41·0	35·1	41·2	41·9	27·7
	May	48·6	44·4	47·2	48·5	47·4	46·0
	June	51·7	53·9	54·2	59·9	56·1	55·5
	July	57·2	59·1	64·9	62·6	61·7	65·0
	Aug	64·4	56·7	59·0	55·5	60·4	60·8
	Sept	47·0	48·5	51·8	49·0	49·5	51·3
	Average	52·6	50·6	52·0	52·8	52·9	51·0

REPORT ON DRAINAGE SURVEYS AND INSPECTIONS, 1920

BY H. R. CRAM, B.SC., A.M.E.I.C.

Field-survey work was commenced in the provinces of Alberta and Saskatchewan about the middle of May and continued well into December. Conditions during this period were very favourable for drainage surveys as this year might properly be termed the fourth in succession of dry years and, as a consequence, marked progress was made in the investigations of the projects which were brought before the department from time to time by petitions, applications to purchase, or otherwise. While, however, dry seasons enable the engineer to more expeditiously carry out his surveys, paradoxical as it may seem, normal or flood conditions are, in most cases, preferable, as, under such conditions the engineer, in his study of the many problems arising in connection with the reclamation of land by drainage, is in a better position to obtain definite and reliable information of the wet or flood conditions, than in a dry year when he has to depend on information obtained from settlers or from personal studies and observations of the district.

ORGANIZATION

The scheme of organization of the field service in operation last season was continued this year and was found to give the same satisfactory results. The field-work was under the general charge of a supervising engineer and the work in each province was under a senior engineer responsible to the former.

Mr. J. S. Tempest, who is the supervising engineer referred to, in addition to performing the regular duties of his office, made many inspections of small drainage projects dealt with under the provisions of Part I of the Reclamation Act of the provinces of Saskatchewan and Alberta. Mr. G. F. Horsey was again in charge of the field-work in Saskatchewan and Mr. G. F. Richan was in similar charge of the Alberta field-work. Operating under the direction of these engineers, there were in each of the provinces one large location party and one or more reconnaissance parties.

The general plan of this organization is that reconnaissance surveys will be made by small parties to enable the department to judge, at the lowest cost possible, whether or not projects brought to its attention are deserving of further investigation and development.

An office was opened this year in Edmonton to serve as headquarters for the field service in the province of Alberta. It proved very convenient during the summer and in the winter afforded storage facilities for equipment which otherwise would have been brought to Ottawa at the close of the field-season. The office also served as a drainage information bureau, much preliminary information regarding drainage being supplied to applicants.

METHODS OF INVESTIGATING DRAINAGE PROJECTS

In the investigation of any particular project, the original reconnaissance survey merely determines the general feasibility and desirability of the scheme. Information as to levels, ground slopes, character of the land, including quality of surface and subsoil, timber conditions, class of vegetation, settlement, markets and availability of transportation lines, is obtained.

If this survey indicates that the project is a promising one, a location party is placed on the work and complete surveys are made, including the determining of contours to one-foot intervals, the location and design of the necessary canals and laterals, the design of structures and the assessment of cost upon lands that will be benefited by the proposed project.

Soil samples are taken at representative points throughout the area to be reclaimed and are tested in the field by means of an electrolytic bridge. This instrument, small in size and handy for field use, operates on the principle of the Wheatstone bridge. The resistance offered by the soil to the passage of a current of electricity is measured by this instrument. This resistance is indicative of the strength of the salts present in the soil. If these tests prove the presence of alkali salts in dangerous quantity the samples are forwarded to Ottawa and chemically analyzed to determine if these salts are sufficient to be deleterious to plant life. This analysis also shows the relative percentages of soil constituents valuable to plant growth. A physical analysis is made to properly classify the soil as to texture and to determine if it is likely to become suitable for agriculture after reclamation.

ALBERTA

SOUNDING LAKE

Townships 36 and 37, Ranges 4 and 5, West 4th Meridian

This lake lies at the end of a valley almost surrounded by hills, about twelve miles north of the town of Monitor, Alberta, on the Canadian Pacific railway. The bed of the lake contains about 9,100 acres and is quite flat, while the shore line is well defined. The water is shallow, not exceeding one foot in depth at low stage, muddy and quite useless for stock-watering purposes except in the early spring. Sounding creek, which flows into the lake from the south, together with the seepage from the adjoining hills and from springs, constitutes the run-off tributary to the lake.

There is no outlet from Sounding lake, but Eyehill creek commences within a few hundred feet of the lake and flows east and north into lake Manitou in Saskatchewan. The bed of this creek is from seven to eight feet above the elevation of the bottom of Sounding lake and has a slight fall, approximately one foot to the mile.

The soil of the lake bed is a heavy clay to an unknown depth, yellowish in colour and becomes quite friable when dry, while along the shore the soil is sandy with patches of boulders. Vegetation on the dry portion of the lake bed is only fair, consisting of redtop, foxtail and slough grass. The growth appears best at 0·7 to 1·5 feet above water-level. Above this elevation the growth appears sparse, stunted and tufted, due, no doubt, to alkali conditions and the sandy nature of the soil.

Electrolytic bridge tests show the alkali content of the soil to exceed 1·75 per cent in the first six inches, that it varies from 0·3 per cent to 0·7 per cent in the next lower twelve inches, and that below this it is 0·5 per cent on the average. This indicates a considerable accumulation of alkali on the surface, which is probably due to the evaporation of the water that has taken place for many years from this large drainage basin. It is, of course, possible that the major portion of the salts present are not of the most injurious type and so would not be as deleterious to plant life as other forms of alkali, but until the report of the Dominion Chemist on the analysis of soil groups is available this will not be definitely known, nor whether drainage will be likely to reduce below the danger point the quantity of the alkali present.

As the drainage area of Sounding lake is approximately 440 square miles it will be necessary to provide an outlet ditch having a capacity of 415 cubic feet per second. Under these conditions the principal elements of an economical ditch would be: bed with 12 feet and slope ·000075 foot. As Eyehill creek is the only outlet available, about 5,000 acres of the lake bed would be flooded each spring to a depth of one foot; therefore this scheme, if other conditions prove favourable, only qualifies as a hay land reclamation project.

The total cost of the scheme is estimated at $78,500 and the area to be benefited as 6,950 acres. The per acre cost would be about $11.50. The value of improved land in this vicinity is not very high, averaging $18 per acre.

As the report indicates, this is not a very desirable drainage project. There is, however, a possibility that this lake might serve as a reservoir in connection with the projected North Saskatchewan Irrigation Project which is to be further investigated during the season of 1921 by the Irrigation Division of the Reclamation Service.

GOUGH LAKE

Townships 35 and 36, Ranges 17 and 18, West 4th Meridian

The possibilities of draining two other lakes—Shooting and Marion—which lie three miles north and which are connected with each other and with Gough lake by a system of natural watercourses, were also investigated at the same time as the latter. The country surrounding and adjoining these lakes is remarkably flat, sloping gently towards Gough lake, which is the centre of a drainage area of approximately 220 square miles. This part of the country is used mainly for ranching, very little grain farming being carried on. The natural grass is of excellent quality for hay and grazing, and cultivated grasses do remarkably well.

Gough lake, which is about 12,400 acres in extent, is a shallow body of alkali water with a depth not exceeding 2 feet, except in very wet years when the water rises from 4 to 5 feet above its normal level. The soil of the lake bed is a dark clay to a depth in excess of 50 feet. A good growth of slough grass extends to the water's edge at the north and south ends of the lake. There is much evidence that a considerable amount of alkali is present in the soil but as to whether or not the effect will be detrimental to ordinary farm crops only an analysis of the soil will show. Samples of the soil were submitted to the Dominion Chemist for analysis but as yet no report has been received.

Adjoining Gough lake to the northeast and extending to Shooting lake, there are approximately 3,400 acres of slough land, the soil of which is an excellent black loam, yielding abundant crops of redtop; as much as 2½ tons to the acre in favourable years. Only a slight appearance of alkali is noticeable in this tract. Shooting lake itself is a permanent body of water, fresh in character, and about 2,300 acres in extent. The soil of the lake bed is a boulder gravel and would be of very little use if reclaimed.

Marion lake is situated a little to the west of Shooting lake and is about 5,000 acres in area; it contains many islands and the water does not exceed in depth one and one-half feet. The soil is a whitish clay which bakes very hard and much alkali is in evidence, with the result that the lack of growth surrounding the lake is very noticeable.

There is no outlet to this large depression and all of the surplus moisture is taken care of by evaporation, which is extreme. No doubt when all the land in the vicinity comes under cultivation, these lakes will decrease considerably in size. The high ridge running north and south on the western side of range 16 divides this area from that of Sullivan lake so that to construct an outlet to the latter would necessitate a maximum cut of approximately 34 feet for a distance of about three miles. The only alternative outlet is a ditch northward to Bigknife creek, as the country south and west slopes towards Gough lake for a considerable distance. Bigknife creek commences within a mile of Marion lake and flows northward to the Battle river; it is of considerable size and has a very pronounced fall and would readily accommodate the water from this drainage area. The extreme cut necessary for this route would be 31 feet for a distance of about two miles.

The total cost is estimated as $460,000, based on the last mentioned outlet, which figures out at a cost per acre of approximately $20. The total area in the scheme comprises, roughly, 33,700 acres, of which the Crown controls 60 per cent. In considering the scheme, the fact must not be overlooked that practically 7,200 acres would be useless except for grazing purposes, which would greatly increase the assessment on the balance of the land affected. Improved land in the vicinity sells for less than $20 per acre. Having regard to the very doubtful value of the soil after reclamation and of the high estimated cost, this scheme does not appear to be desirable at present.

FARRELL AND DOWLING LAKES

Townships 33-36, Ranges 16-18, West 4th Meridian

The area of these lakes, together with some small adjoining and connecting lakes, comprises approximately 14,800 acres. They are situated in a natural depression some 100 to 150 feet below the surrounding hills. There is no apparent outlet. Several small streams contribute water from the high lands and in one or two instances the supply is of a permanent nature, being fed from springs. The water of Farrell lake and of one of the small lakes is fresh but all the other lakes are quite alkali.

The variation in the level of the lakes is quite pronounced from year to year, Dowling lake varying as much as six feet, while Farrell lake maintains a low elevation although it rises approximately four feet in the spring. The latter lies at the northwest end of the valley about 56 feet above Dowling lake and is usually from seven to eight feet deep. At intervals down the valley are six small lakes at different elevations, the lower two being about the same elevation as Dowling lake.

It is not possible to secure a gravity outlet from Dowling within a reasonable distance. The nearest natural channel—Bullpound creek—is three miles south and approximately 65 feet above the lake.

The draining of Farrell lake into Dowling lake, although it would dewater 3,900 acres, is not a desirable measure as a large area of land adjoining Dowling

lake would be permanently inundated as a result. Several of the smaller lakes could be drained into Dowling lake but it is extremely doubtful if the soil would be of use agriculturally, as much of the land affected by these smaller lakes is highly impregnated with alkali.

Farrell lake is ideally situated for an irrigation reservoir and would probably afford sufficient capacity to irrigate 15,000 acres of the valley land at reasonable cost.

As a drainage project this is not feasible or desirable, but the information collected will be very useful in connection with investigations now being carried out to ascertain the irrigation possibilities in this district.

SULLIVAN LAKE

Townships 34, 35 and 36, Ranges 14 and 15, West 4th Meridian

Sullivan lake is situated eight miles south of the town of Castor, Alberta, on the Canadian Pacific railway and covers about 41,600 acres, with a tributary drainage area of 410 square miles. The country surrounding the lake is variable in character; on the south and west sides it is high and rolling, containing much excellent farm land, while to the east there is a gradual slope from the lake to a height of 15 to 30 feet at distances varying from 2 to 5 miles, on which the crops are generally poor, largely as a result of summer frosts and hail storms.

The soil of the lake bed is almost entirely clay, somewhat similar to gumbo, but becoming very friable when dry and retaining moisture to a much greater extent. These conditions are quite marked at the south end of the lake where a considerable portion was dewatered. Vegetation, in general, consists of a growth of weeds resembling pigweed, with scattered clumps of foxtail. In places the growth reaches a height of two feet. Along the northeast side of the lake are stretches of yellowish sandy clay soil, with a thin growth of foxtail and redtop, which does not exceed one and one-half feet in height. In the northwest arm of the lake the soil is a whitish sandy clay which bakes very hard and here the growth is negligible.

Representative soil samples were collected and furnished to the Dominion Chemist for analysis. In nearly all cases the electrolytic bridge tests disclosed alkali content in excess of 2 per cent to a considerable depth. The water of the lake, however, showed a very mild solution of alkali. The toxic effect of the alkali is noticeable on the vegetation, which has a stunted appearance. The efflorescence is noticeable on the surface and to some depth in the soil where large cracks appear. There is much alkali apparent in the land surrounding the lake and a considerable area is not in use on that account.

The most direct outlet may be obtained on the east side of the lake where an arm stretches eastward to a depression where Sounding creek commences, a distance of about two and one-half miles. This creek varies in size from a small watercourse 8 to 10 feet in width, to a coulee 100 feet wide, and is very crooked, meandering for about 100 miles before reaching its outlet in Grassy Island lake near the boundary of the province of Saskatchewan, a lake much smaller in size than Sullivan lake. Certain objections would be found to the use of this creek as an outlet, due to the improvement necessary for almost its entire length and the limited capacity of Grassy Island lake. As an alternative, a diversion, at slight cost, may be made into Berry creek, a distance of about one-half mile, where also considerable improvement in the creek channel would be necessary.

A protest has been made by interested settlers to the use of Berry creek, as the waters of the creek are used for irrigation purposes and it is feared that the land

so irrigated would suffer injury because of the alkaline nature of the territory tributary to the lake. This difficulty might be overcome by allowing the run-off from the lake to occur between irrigation periods if it is proven that these waters are harmful.

In addition to the objections mentioned to the use of Sounding creek as the outlet, the difference in cost of the alternative greatly favours the Berry creek route.

Two schemes—partial (A) and complete (B) drainage—were considered and estimates of cost prepared as follows:—

Route	Scheme	Reclaimable Area	Cost per Acre	Total Cost
			$	$
Sounding Creek	A	30,555	11.41	348,700 00
"	B	37,000	11·97	442,700 00
Berry Creek	A	30,555	10·36	316,500 00
"	B	37,000	11·04	408,500 0C

The value of the land in this locality varies exceedingly as there is some excellent land valued up to $35 per acre, but the great bulk of it is not worth more than $17.50 per acre. Much of this is not at present under cultivation, chiefly because of its being held by large land corporations or because it is considered better adapted for grazing land.

The attitude of farmers in the vicinity as regards drainage is more or less indifferent.

There is no doubt that the scheme could be carried out economically but the presence of alkali in considerable quantity would make the project rather a problematical undertaking. The opening of such a large area of doubtful agricultural value when so much good vacant land exists would not seem a wise and economical policy.

The possibilities of utilizing Sullivan lake as a reservoir in connection with the Northern Saskatchewan Irrigation Project will be fully investigated this year. It is possible that water may be diverted from Battle river or Red Deer river to Sullivan lake, which is quite capable of storing 500,000 acre-feet.

LANES LAKE

Townships 37-39, Range 14 and 15, West 4th Meridian

This lake is situated eight miles north of Sullivan lake and three miles west of the town of Castor, Alberta, on the Canadian Pacific railway. A preliminary investigation of this project was made last season, following the completion of the Sullivan lake surveys.

The lake bed is approximately 2,650 acres in extent, of which about 1,430 acres are periodically flooded or too wet for cultivation and 1,220 acres permanently covered by water. The lake is of a permanent character and except in springtime retains practically the same level throughout the year. It is apparently fed by springs, the water being fresh and clear. The deepest part was found to be three and one-half feet, which is general in the main body of the lake.

Vegetation along the shores is exceptionally good and in places extends into the water. Redtop, which is the principal grass, grows to a height of three feet, and settlers state that as much as two and one-half tons of hay to the acre are cut in favourable years. All the land above the water yields abundance of grass and is cut annually.

The soil underlying the lake appears to be very good, the top soil consisting of from 6 inches to 1 foot of black sandy loam with a stratum of sand from 6 to 12 inches thick between that and the clay subsoil. Only very slight indications of alkali were noticed and electrolytic bridge tests showed this to be negligible to a depth of one and one-half feet and beyond that very little more. On the east side of the lake are a few acres of stony land extending along the shore and into the lake, but the greater portion would be available for cultivation and suitable for almost all farm crops.

The natural drainage of Lanes lake is south by a watercourse or creek to Sullivan lake which has a fall of about two feet to the mile. By improving this connecting link a safe and adequate outlet is provided and it has been ascertained that the affect of this drainage on the level of Sullivan lake will be inappreciable on account of the large superficial area of the latter when compared to the former.

In estimating the cost of the required works, complete drainage only was considered, on account of the almost uniform depth of the major part of the lake. The periodically flooded and wet land would be reclaimed to cultivable land and that under water to hay land. A hold-up gate at the outlet of this lake will be necessary to permit of irrigating the land when required, and a similar gate, together with a 2-foot drop, will be necessary at the outlet of Ellacott's lake, which is situated three miles south of Lanes lake, connecting with the same outlet or creek from the latter.

The total cost of the project is estimated as $22,200, or an average cost per acre of $8.40. The value of improved land in the vicinity ranges from $30 to $40 per acre and prairie land from $15 to $25 per acre.

All the resident owners of land affected in any manner by the project were interviewed and in every case expressions favourable towards drainage were obtained and as the Crown controls 56 per cent of the land included in the scheme it seems an admirable one for development by the Federal Government. In view of the favourable nature of the information obtained on preliminary investigation, it was decided to carry out, during the season of 1921, a detailed location survey of the scheme so that complete details may be available if the department decides to proceed with the reclamation work.

CYGNET LAKE

This lake is situated in township 38, range 28, west of the 4th meridian, and township 38, range 1, west of the 5th meridian, about six miles due west of the town of Red Deer, Alberta.

In the year 1910 the Alberta Central Railway Company (now the Red Deer—Rocky Mountain House Branch of the Canadian Pacific Railway Company) lowered the level of this lake some eight or ten feet so as to permit of the construction of its grade at a minimum cost. The original superficial area of Cygnet lake was 4,840 acres but this was reduced to about 1,500 acres after partial drainage by the railway company. This was, of course, entirely within the powers of the company under its charter, as well as under the provisions of the Railway Act, and no exception was taken thereto by this department.

More recently, one of our engineers, whose duties had taken him to that district on other work, was impressed with the necessity of more complete drainage and he recommended an investigation to determine the feasibility of constructing works to complete the drainage of the lake under Part IV of the Reclamation Act of Alberta and Part IV of the Dominion Government Drainage Regulations.

This investigation was carried out during the period November 21 to December 11, 1920. It was found that the existing drainage ditch had been constructed in the only outlet from the lake—a natural water course situated at the easterly extremity of the lake from whence, by somewhat tortuous course, it reaches the Red Deer river, distant some four miles.

The country surrounding Cygnet lake is rolling and well adapted to stock raising. The cultivated portions at present produce chiefly hay and oats. The grass on the partially reclaimed land is very coarse on account of insufficient drainage, but was being sold at from $15 to $30 per ton during December, 1920 in Red Deer. Some very fine oats were grown on the higher portions of the reclaimed areas. The value of land in the vicinity for improved farms was quoted at $45 to $65 per acre, and for unbroken land $20 to $40 the acre.

The principal feeder to Cygnet lake is Sylvan creek, flowing from a lake of that name, which has a drainage area of 45 square miles. Another creek enters the lake at the southwest corner, which is more or less of a permanent character as regards flow on account of springs located half-way between its source and the lake. As hydrometric data of the Cygnet-Sylvan watershed were not available for a sufficient period of time recourse was had to the data of record pertaining to the Blindman's river watershed, which is very similar in its characteristics and it was decided, after a careful study, to provide for a maximum discharge in this case of 75 cubic feet per second.

The works required consist of six and one-half miles of main canal with bed widths from 6 to 10 feet and one lateral of about one and three-quarter miles in length, with bed widths varying from 3 to 6 feet. One culvert will be required where the lateral intersects the railway grade.

Estimates of Quantities and Cost

Excavation, main canal	105,030 cu. yards	
" lateral	6,922 " "	
Total	111,952 " " at 25c.	=$27,988
Culvert, concrete, 50 cu. yards at $20		= 1,000
Rebuilding highway bridges		= 1,000
Total		$29,988

The system of assessing land affected by the project is as follows:—

A—100 per cent benefit—land 3 feet above bottom of ditch and at present submerged or useless.

B— 75 per cent benefit—land between 1 and 3 feet above bottom of ditch and at present submerged or useless; improved from 25 to 100 per cent in value.

C— 50 per cent benefit—land over 3 feet above bottom of ditch and at present producing coarse hay.

D— 25 per cent benefit—land completely drained but at present producing coarse hay.

Total of Class A	1,187.0 acres
" " " B	771.6 "
" " " C	516.0 "
" " " D	1,253.6 "
Grand total	3,628.2 "

Present value of this land	$ 45,819
Estimated value after reclamation	139,323
Total benefit	93,484
Assessment rate per $1.00 of benefit	32.08 cents

The cost of drainage is approximately $8 per acre.

Soil samples were taken from the bed of the lake and forwarded to Ottawa for analysis. The field tests made by means of the electrolytic bridge do not indicate the presence of alkali to any extent, but until the report of the soil chemist is received no definite opinion can be given regarding the probable value of the soil after reclamation.

The system of drainage, as proposed, does not provide for the complete reclamation of the land underlying the lake but leaves a small pond of about sixteen acres; otherwise the cost would be greatly increased, possibly doubled. The retention of this small water area will provide the settlers in the immediate vicinity of the lake with stock-watering facilities.

This project is now in readiness for construction by the Federal Government under the Dominion Reclamation Act and Drainage Regulations, and the Drainage Regulations of Alberta, and is strongly recommended.

LAC-LA-NONNE

Township 57, Ranges 2 and 3, West 5th Meridian.

LAKE MAJEAU

Township 57, Ranges 3 and 4, West 5th Meridian.

Lac-la-Nonne was found upon investigation to cover about 3,000 acres completely contained within high and steep shores and soundings taken showed a depth of 30 feet of water without reaching the deepest portion of the lake. For this reason it was not considered further as a reclamation project.

Lake Majeau is situated about twenty-five miles west of Busbu station on the Edmonton, Dunvegan and British Columbia railway, and fifteen miles north of Gunn station on the Canadian National railway. Its natural drainage is into Lac-la-Nonne by a creek flowing generally through a deep ravine, especially in the lower part of its course. The district adjoining and adjacent to this lake is rolling in character and contains a number of small sloughs, while the soil on the higher ground is thin, sandy and stony. This territory is best adapted for stock raising and the reclamation of the lake bed would make available an additional area of land suitable for the production of hay and oats.

The attitude of the settlers towards drainage is undergoing a gradual change. In 1915 and 1916 the lake level was unusually high and much of the best land was flooded which, of course, brought the question of drainage to the fore, but each succeeding year without a recurrence of the flooded conditions has found these land owners more or less indifferent to drainage. At the present time only a few farmers on certain fractional quarter-sections and some outside seekers of cheap land are very much interested in the project.

Partial drainage of the lake by lowering its level two feet would provide sufficient fall for the reclamation of about 220 acres of wet land along the inflowing creeks and would prevent the overflow of some of the meadows which are now periodically submerged. This would require about 3,000 cubic yards of excavation which at 25 cents per yard would amount to $750, or about 85 cents per acre benefited. To completely drain the lake it will be necessary to excavate 151,000 cubic yards of earth, and to improve the channel of the creek below the outlet to Lac-la-Nonne, all of which would cost approximately $31,200. The area which would be reclaimed is roughly 4,590 acres, which figures out at a cost of approximately $7.30 per acre, including supervision, cost of surveys, etc.

Good hay land in the vicinity including upland, is worth $10 to $15 per acre and the value of the reclaimed land would be at least $15, from which it would appear that complete drainage would be economical. In view, however, of the opposition of some of the interested settlers to complete reclamation and the general indifference of others to any scheme of drainage, this is not a project which can be recommended at the present time.

CHIP LAKE

Townships 53 and 54, Ranges 9, 10 and 11, West 4th Meridian

This lake is situated on the main line of the Canadian National railway some eighty miles west of Edmonton and has a superficial area of approximately 18,554 acres.

Owing to the pressure of other field-work last season it was only found possible to make a brief reconnaissance investigation of the project and this was carried out after the freeze-up in December, 1920.

Soundings of the lake bed were taken from the ice at intervals of from 200 to 600 feet along each north and south section line. As the bed proved to be very uniform the number of soundings taken was quite sufficient to provide the data for a fairly accurate and detailed working map, showing one-foot contours, on which a projection of the main ditches could be made.

Of the total submerged area only 2,315 acres are covered to a depth of over six feet, and 967 acres of the latter are covered by a depth of over seven feet. It would thus appear that there is a probability of approximately 15,000 to 16,000 acres of the present submerged area being converted into farming and hay lands within a reasonable cost. To this area should be added about 5,000 acres of adjoining land which may be converted from wild hay land, or worthless marsh, to farm land, making a total area that would be benefited of about 20,000 acres.

At each sounding an attempt was made to ascertain the nature of the soil of the lake bed. It was found that soft mud and clay prevailed almost consistently throughout the entire lake, excepting an irregular belt from 100 to 400 feet in width around some portions of the shore which consisted of sand, gravel and stones. This information is of great importance, as some objectors to the project contend that the lake bed largely consists of stones and boulders and that it would therefore not be worth reclaiming.

As a result of the limited investigation made and data collected, the following estimate of cost is only approximate:—

Main canals, 21·5 miles	$135,225
Laterals, 22·7 miles	30,000
10 bridges	8,000
20 culverts	7,000
Total cost	$180,225
Average cost per acre for 20,000 acres in lowering level of lake 6 feet	$9

In view of the promising nature of the scheme it has been decided to have a location party thoroughly investigate the project during the season of 1921.

MAGLOIRE LAKE

This lake is situated in township 79, range 21, west of the 5th meridian, about eight miles north of Fahler station on the Edmonton, Dunvegan and British Columbia railway, and ten miles northwest of Kimiwan and Winagami lakes, which were also investigated as drainage projects by this department. The superficial area of the lake is approximately 1,700 acres. This scheme is also a development of an application received from a private individual, but for reason of its size and probable cost it was too large to be so handled and it was decided to investigate the feasibility of dealing with it under Part IV of the Drainage Regulations, with a view to making available for soldier, or other settlement a considerable area of land worthless in its present condition.

As one of the large survey parties was operating in this district it was convenient to undertake the investigation in September, 1920.

The water area of the lake, at that time, was ascertained by surveys to be about 1,700 acres and the adjoining marshes and swamps to comprise an additional 1,100 acres. The natural outlet is on the west side, but has been obstructed by beaver dams and consequent silting until a marsh has been formed over which water spreads until it is collected by a natural watercourse flowing southwesterly into Lalby creek from whence it finally reaches Smoky river in section 31, township 78, range 23, west of the 5th meridian. The visible portion of the outlet commences

about one-half mile from the normal shore of the lake but disappears again in another swamp before reaching Lalby creek. To overcome this lack of definite channel the outlet ditch is projected through this swamp to the latter creek, thus providing for the reclamation of 500 acres at this point, which brings the total reclaimable area to approximately 3,300 acres.

Along the west side of the lake the country has been practically cleared by fires while on the north and east sides heavy timber extends to the water's edge.

The drainage area of the lake is estimated as twelve square miles and it has been determined that a discharge of fifteen cubic feet per second must be provided for by the outlet works. About 30,000 cubic yards of earth will require excavating in the construction of the main canal and lateral which, at a unit price of 25 cents, will amount to $7,500. To this sum must be added $250 for clearing six and one-half acres (right of way), $1,000 supervising and $1,000 for bridges, making a grand total of $9,750, or a per acre cost of about $2.90. It is quite probable if the larger project (Winagami-Kimiwan) nearby is undertaken that a unit price of about 20 cents could be obtained by contract for this scheme, which would lower the per acre cost to $2.40.

A sample of the lake water and several samples of the soil of the lake bed were obtained and submitted to the Dominion Chemist for analysis. When his report is available and the probable value of the land after reclamation is known, the department will be in a position to definitely decide whether or not it will proceed further with the scheme, which has been shown after careful field investigation and surveys to be economically feasible as well as desirable.

KIMIWAN AND WINAGAMI LAKES

Townships 76, 77 and 78, Ranges 18, 19 and 20, West 5th Meridian

Lakes Kimiwan and Winagami have hitherto been considered one project, but investigation shows that it is not economically feasible to drain them in the same direction, and separate estimates have been prepared as for two different projects.

Lake Kimiwan.—This lake is a shallow lake of about 10,000 acres, situated at McLennan on the Edmonton, Dunvegan and British Columbia railway. This is at the junction of the Central Canada railway which passes northerly along the west side of the lake to Peace river. There is no permanent outlet to the lake, but, on occasions of extreme high water there is an overflow westerly to Reed lake and Peavine creek, thence southerly, to the Smoky river. This course is followed in projecting the main drainage ditch.

At the present time there is but little settlement around the lake. The townsite of McLennan is on the south shore, and there are a few settlers along the west shore along the line of the Central Canada railway.

From Lake Kimiwan to Reed lake, the country has been burned over several times and is now covered with scrub poplar and willow. There are a number of hay meadows in the low spots.

From Reed lake a creek flows south to the Peavine, though in places the course of the stream could not be traced in the swamps. This part of the country is fairly well settled, particularly from the crossing of the Edmonton, Dunvegan and British Columbia railway near Donnelly station south to the Smoky river. The majority of the settlers are French Canadians, who have been in this district for some years.

The soil is a good black loam on a clay subsoil, which after systematic drainage would make excellent farming land. On the drier portions of the unbroken land there is a heavy growth of peavine and thick grasses. There is quite an extent of open prairie, and as the timbered portion has only light poplar and willow, there is a con-

siderable area under cultivation. Unsystematic attempts at drainage have been made which partially reclaimed certain sections to the detriment of others. A good main ditch along the general course of the creek, as suggested, would supply a basis for an efficient drainage system for the whole district.

The scope of this investigation was extended to include little more than the disposal of the Kimiwan lake drainage, but it is considered that the project should include the formation of a district to comprise all the drainage area of Peavine creek, which might require more extensive and detailed surveys in connection with the final location of the main ditch.

Appeals have been made by the settlers for improvement of the drainage of some of these lands on account of the inadequacy of the creek where it has been obstructed by beaver dams to carry the flow. It was noticed, however, that one of these dams which had been broken by spring floods, was carefully repaired by some of the settlers in order to make it easier for stock to reach the water and to provide a suitable place for harvesting ice in the winter.

The drainage area of Kimiwan lake, including that of Reed lake, is about 100 square miles, and the rate of discharge required to properly take care of flood conditions is estimated to be 150 cubic feet per second.

The length of the main ditch projected is sixteen and one-quarter miles.

An estimate of the cost of complete drainage of Kimiwan lake is as follows:—

Area reclaimed in Kimiwan lake, including adjoining marsh....	11,620	acres
Area reclaimed in Reed lake, including adjoining marsh..	530	"
Hay marsh between Kimiwan and Reed lakes..	190	"
Hay marsh and swamps between Reed lake and Edmonton, Dunvegan and British Columbia railway..	280	"
Hay marsh and swamps along ditch south of Edmonton, Dunvegan and British Columbia railway..	1,200	"
Total..	13,820	"

Right of way, 60 acres at $20 per acre..			$ 1,200
Light clearing, 27 acres at $10 per acre..			270
Excavation, main ditch..	299,744		
" laterals in Kimiwan lake.. ..	69,371		
Total excavation..	369,115 cu. yards at 20c.		73,823
Pile bridge at Central Canada railway..			1,500
Highway bridges, 7 over 18-foot ditch, at $500..		$3,500	
Highway bridges, 8 over 10-foot ditch, at $250..		2,500	
Highway bridges, 10 over 6-foot ditch, at $200..		2,000	
			8,000
Improvement of Peavine creek..			2,000
			$86,793
Cost per acre of land reclaimed in beds of Kimiwan and Reed lakes..			$7.15
Cost per acre including land reclaimed along Peavine creek..			6.29

The investigation of the Kimiwan lake project has shown it to be entirely feasible, economical and in the public interest, and construction is recommended.

Winagami Lake.—Soil conditions here are quite similar to those at Kimiwan lake, about two miles distant.

The country lying east of the lake to the South Heart river was examined, but no economical route for drainage in that direction was discovered. These surveys were extended to the south, between the lake and a tributary to the South Heart. Complete drainage in this direction is not practicable, but the lake could be lowered about seven feet, leaving a pond of about 3,000 acres, thus reclaiming 8,000 or 9,000 acres.

The plans for this work are not sufficiently advanced for a complete detailed study and report of the project, and it would probably be inadvisable to consider so extensive a drainage into the South Heart river until control of the Lesser Slave

lake level is established. As there is no outlet from Winagami lake at present, the creation of an outlet would add about 40 square miles to the drainage area of the South Heart river, which empties into the west end of Lesser Slave lake, where flood conditions are extremely bad at the present time.

Partial drainage of this lake is quite feasible, but until some further particulars have been ascertained, and pending the carrying out of investigations to ascertain the probable effect of diverting a large quantity of water, annually, to Lesser Slave lake, a definite recommendation under the circumstances is not advisable at present.

ATHABASKA PROJECT

Townships 67 and 68, Ranges 20 and 21, West 5th Meridian

Representations were made to the department by the Board of Trade of Athabaska, Alberta, and by Local Union No. 498 of the United Farmers of Alberta, regarding the desirability of reclaiming the large areas of vacant Crown swamp land in these townships. By resolutions presented to the department it was pointed out that this land, in its present condition, acts as an effectual barrier to the settlement of a large tract of good land lying north of it and south of the Lac la Biche river district. It is impossible, under existing conditions, to construct roads through the intervening swampy section. It was also brought to the attention of the department that such a scheme as proposed would be in the public interest, as it is very favourably situated as regards markets (town of Athabaska, Alberta) and transportation facilities.

A reconnaissance investigation was arranged and carried out last season, covering the territory bounded on the north by the Athabaska river, on the west by Tawatinaw creek, on the south by the road allowance running east and west two miles south of the line between townships 65 and 66, and on the east by Pine creek. The Athabaska river and Pine creek both flow north in deep valleys; the valley of the former having an average depth of 150 feet below the general elevation of the land investigated. Along this valley the soil, for a distance of one and one-half miles back, is mostly sand deposited during the formation of the river bed. This deposit forms a ridge which cuts off the flow to the Athabaska river of the territory examined. The country east of this has the usual glacial formation. The remains of numerous beaver dams are evidence that the muskegs and swamps abounding in this territory have been formed by the gradual disappearance of the original creeks and the deposition of the matter which would otherwise have been carried away by them. At the present time there are very few creeks, those existing being too narrow and shallow to carry the run-off from the district. The muskegs are covered with moss to an average depth of two feet.

Portions of the country which have been privately drained have produced remarkably good crops. One settler drained, cleared and grubbed fifty acres of muskeg and tamarac swamp from which he now obtains fine crops of oats annually, averaging 115 bushels to the acre. Others have had similar results.

Considerable clearing and grubbing will be required if drainage is undertaken, on account of the scrub growth of timber which is somewhat prevalent over the complete tract. In a project of this character clearing of the land is almost as essential as the construction of ditches; in fact, some of the tamarac swamps can be more efficiently and economically dried out by clearing than by ditching.

Four and six-tenths per cent of the district is heavily timbered with spruce and tamarac; forty-eight and nine-tenths per cent is lightly timbered with poplar, birch, spruce and tamarac; twenty-nine and seven-tenths per cent is covered with willow and poplar scrub, and sixteen and eight-tenths per cent is open swamps and marshes.

The cost of the project is estimated as $150,861, made up as follows:—

Excavation	$101,082
Culverts	26,400
Bridges	8,380
Clearing	475
Right of way	809
Engineering, supervision, etc.	13,715
Total	$150,861

The total reclaimable area is 38,573 acres, making the average cost per acre $3.91. The Crown controls 84 per cent of the land affected by the scheme.

Before making a definite recommendation regarding this project it is desirable that complete tests be made by the Dominion Chemist of soil samples from this district, although there is very favourable evidence that in every case where the land has been reclaimed the soil has proven to be of excellent worth for agricultural purposes and this, coupled with the low cost of works, marks the scheme as deserving of very careful consideration.

FLOODED AREAS IN THE VICINITY OF LESSER SLAVE LAKE

Much damage and very widespread distress have been caused, especially in the years 1919 and 1920, through the flooding of the low-lying lands around the shores of Lesser Slave lake. This flooding has occurred from time to time during past years, but never before to the knowledge of the oldest settlers has the flooding been so serious as during 1920. The elevation of the very extensive hay meadows around the shores is so little above the normal lake level that a slight rise in the lake affects and causes the flooding of large areas. It has been estimated that the value of the hay cut in this locality during the year 1920 fell approximately $1,000,000 below that of previous years. The inhabitants estimate that 200,000 acres of land were flooded and rendered unprofitable through the rising of Lesser Slave lake.

As a result of these untoward conditions petitions were made asking the Dominion Government to take immediate action to remedy the evil. A small survey party was instructed to make a reconnaissance with a view to ascertaining the most economical plan of increasing the capacity of the outlet—Lesser Slave river—in order to lower and maintain a lower level of the lake. At the same time a study was made of the causes which led to the rising of the lake in recent years. The results of these investigations are here briefly summarized:—

Causes of the Rising of Lesser Slave Lake.—Authentic records of the lake level date no further back than 1915, but when these are compared with the amount of precipitation from year to year it is found that there is a marked relation between the lake level and the amount of precipitation. It is evident that the higher precipitation of 1919 and 1920 has had a very marked effect on the higher lake level recorded in these years. There is no doubt, too, that varying conditions in the bed of the outlet channel, Lesser Slave river, have had much to do with the rise of the lake. Log jams that occurred in 1920 undoubtedly backed up the water to a considerable degree. Twenty-five or thirty miles down the river from the lake is a gravel bar at a point near the confluence of Saulteau river with the main channel. This gravel bar is six feet higher in elevation than the bed two miles farther up stream. Whether this bar has been formed in recent years, or has existed for a long period, there is no evidence or record to show. It is however very certain that its removal would materially tend to lower the level of the lake by increasing the average hydraulic grade from 0·27 foot to 0·47 foot per mile. The fall could be further increased by straightening and improving the channel back to the lake and thus increasing the fall from 0·27 foot per mile to 0·79 foot per mile.

Extent of Flooded Area.—The total flooded area has been estimated at 200,000 acres, but this includes flooded land lying at a considerable distance from the lake in the Heart, Iroquois and East and West Prairie river basins. Much of this land however has an elevation of thirty or forty feet above the level of Lesser Slave lake and so could not be affected by the high water-level. Probably less than 50 per cent of the 200,000 acres mentioned above is affected by the high water. The approximate area affected can only be ascertained by a system of surveys. The flooded lands above the area affected by the fluctuations of the lake level are of great extent and the land is of great potential value. To drain these, however, would necessarily increase the discharge into the lake, and if such a project is anticipated it would be very unwise to undertake any improvements in the channel of Lesser Slave river without making due allowance for the accommodation of this extra volume of water. Petitions, however, have been received from the resident owners in these localities asking for a Government investigation with a view to affording relief from the flooded conditions and these petitioners should receive the same consideration as those around the lake shores.

Plans to lower and control Lesser Slave Lake.—The question of lowering this lake involves consideration of the interests of owners of the low-lying lands around the shores, the shipping interests on the lake, and the fisheries. The land owners are in favour of a permanent lowering of the lake. In 1914 or 1915 a channel was dredged out and made navigable for the lake boats to reach Grouard and Buffalo bay from the main body of Lesser Slave lake, and a lowering of the lake to the level desired by some of the land owners would so reduce the depth of this channel as to render it unserviceable. It has not been ascertained how an alteration of the lake level will affect the fishing interests of the companies engaged in that industry and of the settlers around the shores of the lake. During the lower stages of the lake it has been stated that the fishing companies were more prosperous than during the higher stages.

Two principal plans have been considered for lowering the lake level:—

1. To cut through the Saulteau gravel bar to a depth of 6 feet and a bed width of 100 feet. This work would involve about 102,237 cubic yards of excavation, which at 25 cents would cost approximately $25,000.

2. To improve the whole course of the river from Sawridge to Saulteau Landing making a number of cut-offs and straighten out the winding course of the river. This would include the above cutting through the gravel bar at Saulteau. This work would involve the excavation of 881,685 cubic yards which at 25 cents a yard would amount to $220,420.

Recommendations.—It has been recommended that a further and more detailed investigation of the outlet of the lake should be made in the early spring of 1921, and should the conclusions regarding the removal of the gravel bar at Saulteau be confirmed, that the work be commenced at once.

It has also been recommended that an investigation be made of the whole of the flooded area with a view to ascertaining the most feasible plan for its complete reclamation.

ROCKY MOUNTAIN HOUSE DRAINAGE PROJECT

This project is contained in townships 36, 37, 38 and 39, ranges 4, 5, 6 and 7, west 5th meridian, and lies to the south and east of Rocky Mountain House, Alberta, being roughly outlined by the following towns and stations, all of which are in the province of Alberta:—Rocky Mountain House, Dovercourt, Stauffer, Raven, New Hill, Evergreen, Alhambra and Condor.

This tract of land is near the branch line of the Canadian Pacific Railway from Red Deer, Alberta, and is some forty-five miles from that city.

A reconnaissance of the project was made during the fall season of 1920 to ascertain if a feasible scheme could be found to drain this large area of open muskeg which is worthless in its present condition, unsafe to travel on except when frozen and, according to the settlers, the chief cause of the local early frosts that do considerable damage to the crops each year.

The attitude of the resident owners was ascertained by means of a petition circulated among them and it was found that in every case they were favourably inclined towards drainage and the most interested ones were those who were obtaining the best living under the existing circumstances.

The soil in the district varies greatly. On the ridges it is a sandy loam; on the lower but dry land it is often a chocolate loam with subsoil of clay; in the hay meadows there is from 6 inches to 1 foot of moss underlain by clay, while in the open muskeg the moss is very much deeper, ranging from 3 feet to 7 feet in depth over a clay subsoil. There is no trace of alkali in the tract examined, but soil samples representative of the various types of the soil were collected and are now being analysed by the Dominion Chemist in order that the value of the soil after drainage may be fully known. The timber in the district is still of some commercial value and is being cut where obtainable for such uses as telephone poles, ties and fence posts. On account of the unprosperous condition of the settlers, it forms a valuable asset, so much of the land in its present condition being unproductive. Access to the district is very difficult owing to the absence of good roads and trails. The only first class highway in the district runs from the town of Rocky Mountain House to Reindeer post office, which is in the northern portion of the district investigated. Until drainage is carried out, road making will be very expensive and practically impossible, with the result that there will be very little opportunity of intercommunication through the district.

The investigation disclosed that there are sufficient safe and natural outlets in the district to provide for the run-off in the event of the reclamation scheme being undertaken and that it will only be necessary to slightly improve some of these natural channels and to remove beaver dams and other obstructions.

A preliminary estimate of the cost of the proposed drainage works is as follows:—

Excavation	$178,609
Bridges	26,500
Right of way	800
Drops	3,000
Engineering and supervision	9,540
Clearing out natural channels as outlets	10,000
Total cost	$228,449

The total area in the scheme is approximately 45,440 acres which makes an average cost per acre for drainage of about $7. There are in the scheme several thousand acres of high land which would derive considerable benefit indirectly, and if these are assessed, as they may be, for indirect benefit, the average cost per acre would be reduced to approximately $6.

In view of the very favourable nature of the reconnaissance report, it has been decided to make a complete location survey of the project during the season of 1921 with a view to having the necessary drainage work carried out by the Federal Government under the provisions of the Drainage District Act of the province of Alberta and of Part IV of the Dominion Government Drainage Regulations.

BIG LAKE DRAINAGE PROJECT

An investigation was made of the feasibility of draining Big lake, situated in the north half of township 53, ranges 25 and 26, west of 4th meridian, near the town of St. Albert and about ten miles from Edmonton.

This lake during the greater part of the year covers an area of about 2,550 acres to a depth of three feet, but during the spring and early summer rises to a height of about four feet above its normal level, submerging a total of about 6,000 acres.

The majority of resident owners whose lands would be affected by the drainage of the lake are strongly in favour of reclamation. Three owners, however, have protested against this, having in mind the revival of a scheme for making the lake a summer resort within convenient driving distance of Edmonton. The property of these objectors is not affected by flooding so that they have nothing to gain by reclamation. In its present condition the lake is too shallow and overgrown with weeds to be suitable for boating during the greater part of the summer and a proposal to raise the lake level by means of a dam has been objected to by those owning lands subject to flooding.

The outlet of the lake is Sturgeon river, which flows northeasterly through the settlement of St. Albert. During the freshet season considerable portions of the valley through which the Sturgeon flows are subject to flooding.

To completely drain the lake and prevent flooding, a main canal with a capacity of 1,600 cubic feet per second will be required to be constructed through the lake and the Sturgeon river dredged to a point about ten miles below the lake. The excavated material in the lake would be used in the construction of levees on each side of the canal to prevent the flooding of the reclaimed area in time of high water. The construction of these works would involve the excavation of 952,700 cubic yards of earth which at 22 cents would amount to $209,594. In addition to this there would be other earth work such as borrow and shaping of levees, costing $11,461, making a total cost for earth work of $221,055. The average cost per acre of the land benefited would be $36.60.

By this plan for complete reclamation the value of 1,600 acres would be increased from $35 per acre as hay land to $60 as first-class farm land; 1,885 acres would be increased in value from $15 per acre to $60, and 2,552 acres, now permanently submerged, would become first-class farm land of equal value to any in the district.

In addition to complete drainage the system of levees lends itself to the adoption of a scheme of irrigation by which the whole of the reclaimed area, at a comparatively small additional cost, may be irrigated as required throughout the season. The adoption of this combined plan of drainage and irrigation would convert this shallow, unsavoury, mosquito breeding swamp into one of the richest and most productive tracts of land in Western Canada. The situation of the land, right on the railway and near the capital of Alberta and the rich soil when well drained and irrigated, would be ideal in all respects for intensive market gardening. The cost of reclamation compared with the increased value of the land would undoubtedly make it a profitable investment.

A plan for partial reclamation has also been worked out. This scheme would permit the periodic flooding of the present bed of the lake during periods of high water, but would ensure the complete drainage of the whole area so that the extensive hay meadows could be cut every season. This method, though not so desirable as complete reclamation, would ensure tremendous yields of hay. The average cost per acre would amount to $33 for the construction of the ditches and laterals. This plan would not be so profitable as complete reclamation.

Saskatchewan

WATERHEN LAKES PROJECT

Townships 44, 45A and 45, Ranges 21 and 22, West 2nd Meridian

A drainage district, designated as "No. 18," was erected May 31, 1920, under the drainage laws of the province of Saskatchewan, following upon the investigation made by the Reclamation Service during the preceding year which showed the project to be desirable in every respect. Tenders were called for the construction of the drainage works and on the 26th October, 1920, the contract was let to the Lount Engineering Company of Winnipeg, Manitoba, at a unit cost of 21.9 cents per cubic yard for earthwork. The total excavation is estimated as 666,000 cubic yards and the total cost as $169,195. As 13,880 acres will be benefited by the drainage works, the cost per acre is $12.20.

The actual work of construction has already commenced and it is expected that the scheme will be completed by the fall of 1922. A very complete preliminary history of this project appeared in last year's report of the Reclamation Service.

WHITESAND RIVER PROJECT

This scheme is in township 32, ranges 9 and 10, west 2nd meridian, and is the development of an application received by the department for the drainage and purchase of one-quarter section under the provisions of Part I of the Drainage Regulations. The investigations of one of our engineers showed that a small scheme would not be economically feasible. The engineer recommended that the scheme be investigated as a departmental project under Part IV of the Drainage Regulations.

The Whitesand River valley in this locality is quite wide, forming extensive hay meadows to which as they are largely controlled by the Crown, settlers come from considerable distances to cut hay under departmental authority. Cutting is interfered with in wet years, and to a lesser extent even in comparatively dry years, with the result that many tons of valuable forage goes to waste annually which could be saved and in fact augmented by the construction of a combined drainage and irrigation scheme.

The reconnaissance survey mentioned above was made in September, 1920. Alternative schemes were considered:—

1. To improve the channel of Whitesand river so as to permit of the project being developed as a hay scheme—partial drainage.
2. To permanently drain the area.

The former scheme would involve the excavating of some 11,500 cubic yards of earth and the construction of four bridges at a total cost of $6,426, this being at the rate of $2.20 per acre of land included (2,939 acres); the latter scheme would involve the excavating of 74,900 cubic yards and the same number of bridges at a total cost of $28,470 at the rate of $5.40 per acre affected (4,717 acres).

Alkali is prevalent in the district, being plainly visible in white patches, but it is evidently not of the character harmful to plant growth, as the Dominion Chemist who analysed soil samples from the locality reports that, while the area is undoubtedly one eminently suited for the growth of hay, there would appear to be no reason, from the standpoint of richness, alkali content and the possibilities of improvement in texture by drainage and cultivation, why it could not eventually become one well adapted to the growth of cereals and ordinary farm crops.

It is proposed to have a further examination made of this tract with a view to classifying the surface soil, as a considerable area is strewn with small stones and boulders. Upon the completion of this examination it will be possible to decide whether or not this scheme which has been shown to be economically feasible, is one that the department should undertake under Part IV of the Drainage Regulations.

EAST MOOSE RANGE

During the season of 1920 a reconnaissance survey to determine the possibilities of drainage was made of the district lying east of the range line between ranges 10 and 11, west of the 2nd meridian and bounded by the Saskatchewan river on the north, the Sipanok channel on the east and the Carrot river on the south. The total area included in this tract is approximately 600 square miles. The district is accessible from the south by road and trail from Tisdale, Saskatchewan, a distance of 50 miles, while from the east it may be reached in the summer by water transportation via Carrot river from Pas, Manitoba, a distance of some 100 miles. The only settlement in the district is the trading post of the Hudson's Bay Company near the Red Earth Indian Reserve. Only two townships have been subdivided to date.

Owing to the extent of the territory investigated it is rather difficult to treat the district as a whole, as the natural features such as timber, soil and vegetation vary greatly according to locality. For convenience of treatment the tract has been divided into the following sub-districts:—

1. Petaigan river drainage basin.
2. Southern portion of range 10.
3. Big Muskeg.
4. Red Earth and Mud lakes.

PETAIGAN DISTRICT

This consists of the northwestern portion of the tract and contains about 153,000 acres. The natural outlet is the Petaigan river which flows in a northerly direction through range 11 to its confluence with the Saskatchewan river. This river does not adequately drain the tributary land because the main stream and practically all the branches are more or less completely blocked by timber jams, accumulated débris and beaver dams. On account of these impediments to flow the spring floods are much delayed in running off, so that a large portion of the district is very swampy.

The soil, for the most part, throughout this area is excellent, consisting of clay and clay-loam overlain with muck to an average depth of about six inches. It is very productive, growing very heavy and tall red-top in the open places which were dry enough.

A part of this district, covering about 90,000 acres, is susceptible of drainage, but, as only about 30 per cent is open land, the development of this scheme under present conditions is not recommended. The nearest available market is Tisdale, seventy miles south. Possibly on the completion of the Melfort-Pas railway branch the demand for land may make such a project an economical one.

SOUTHERN PORTION OF RANGE 10

This includes the southwestern part of the district, containing some 40,000 acres, the northern part of which consists of burnt-over stony ridges interspersed with stretches of muskeg with underlying soil of gravel and boulder-strewn clay. The southern portion is covered with very heavy timber, mostly spruce and poplar. Drainage is not recommended.

BIG MUSKEG

This name is applied by the Indians to that district which lies, roughly, in ranges 8 and 9, between the Saskatchewan and Carrot rivers, and contains approximately 250 square miles.

This entire area appears to be grown over with thick moss to a depth of four feet and covered very largely with small spruce and tamarac. In many places the moss is semi-floating, the depths varying to seven feet, while in others isolated ridges crop up which are grown over with jackpine, scattered spruce and some poplar.

This is not an attractive project, as drainage will prove very expensive, and from observations, though rather limited, made of the soil conditions, it is questionable whether the land would be of much value after reclamation. Further action is not recommended.

RED EARTH AND MUD LAKES DISTRICT

The land included covers an area of approximately 80,000 acres, mostly in townships 52 and 53, ranges 5, 6 and 7, west of the 2nd meridian. This appears to be the most desirable portion of all the land cruised in East Moose Range, as it is practically all open, level country, consisting of marsh meadow, bog, reedy sloughs and the shallow, weed grown Red Earth and Mud lakes. On its western side lies the Big Muskeg, to the north heavy timbered areas, while on the east and south it is bounded by the Sipanok channel and Carrot river.

The soil of the district consists of clay loam and clay covered by varying thicknesses of muck and alluvial silt. It is of excellent character and grows heavy crops of red-top, blue joint and slough grasses. The Indians of the Red Earth Reserve engage rather extensively in raising cattle and ponies and they cut and make hay on the shores of these lakes. This hay is of fine quality and averages two tons to the acre. Their garden produce, which consists chiefly of potatoes, grows well.

The difficulty to overcome in draining this area is the regulation and control of the Carrot river, which overflows its banks in periods of flood affecting thirty miles of the southern boundary of this district. As the banks of the river are slightly higher than the land lying back a short distance, it takes a considerable time for this land to dry out after the Carrot river subsides. To prevent the annual overflow and flooding will require extensive improvements to the river channel as well as the construction of dykes for a distance of some thirty miles. At the present time this project would not prove economically feasible as it is too remote from settlement and inaccessible. The nearest market is Pas, Manitoba, situated 100 miles down the Carrot river.

The necessity and desirability of undertaking drainage in the East Moose Range will not be felt until other more favourable reclamation projects have been considered and the demand for 'outlying' land is more pronounced than at present.

CENTRE MOOSE RANGE DRAINAGE PROJECT

Townships 49 and 50, Ranges 11, 12 and 13, West 2nd Meridian

During the field-season of 1919 a reconnaissance survey of this project was carried out and in view of the very favourable nature of the report submitted, it was decided to have a complete location survey of the project made, which was accordingly carried out during the season of 1920.

Settlement first took place in this general district in the year 1912 when a few homesteads were selected and filed on. These were situated not far from the north bank of Carrot river, which lies at the southern extremity of Moose Range district.

At that time the land was in many places covered with water and the soil generally was in a water soaked condition; but it was felt by the settlers that with grubbing, breaking up of the soil and the building of a few roads and ditches that the land would soon be made suitable for agricultural purposes. During the years 1913, 1914 and 1915, settlers continued to file on homesteads in the district, built log houses and attempted to break up little plots of land, as well as giving much of their time, without remuneration, for the construction of roads and ditches. Successive years from 1912 to 1916 produced no material change for the better in the condition of the land, as each spring there would be the usual freshet, the water remaining on the land till July, and if the season was particularly wet, throughout the entire summer. This condition would make the breaking up of the land practically impossible except on small ridges a foot or two higher than the surrounding country, and even on these

higher areas it was found that only in exceptional spring seasons was it possible to get the seeding done until June or July, as the water-table would be only a short distance from the surface of the ground. Consequently the crop was usually either cut green or left standing to be destroyed by frost. After three or four years of such experience, it became evident to the majority of the settlers that outside aid would be necessary if the agricultural possibilities of the district were to be developed. A number of settlers who had taken up land abandoned their holdings and left the district, while others remained on their homesteads, realizing the benefits that would be obtained if drainage were undertaken, and took steps to interest the Government of the province of Saskatchewan as well as the Federal Government in their plight.

The majority of the resident owners interviewed in the district were anxious that drainage be undertaken, provided works could be constructed at a reasonable cost, and in order that conclusive proof of their sentiment in the matter might be on record, as many of the inhabitants of the district as it was possible to interview were seen and statements in writing procured regarding their attitude. As a result of this effort and by a petition circulated by one of the resident owners of land in the district, it was possible to get the written opinion of 225 owners of land, representing approximately 40,500 acres of land. It was found impossible to include in the drainage district all of the land owned by these settlers and a considerable area of reclaimable land had, unfortunately, to be left out in order that the Dominion Government might be in control of 50 per cent of the land in the proposed district. Within the boundaries of the district as proposed, the attitude of the residents, as shown by petitions and written statements, is as follows:—

Resident owners in favour of project, controlling	16,560	acres
Crown lands	54,160	"
Total	70,720	"
Attitude of owners unknown, controlling	36,660	"

(It was impossible to ascertain the views of the owners of this land as they were absent from their homesteads at the time our engineers were in the district, but inasmuch as no petitions against drainage have been received from any land owners within the proposed district, it is not considered that these will look with disfavour on the drainage project.)

The land in the central and southern portion of the district has a top soil of from 2 to 10 inches of humus with a subsoil of sand or clay. On the higher land, the depth of the top soil is generally less than that of the lower swamp or slough land and the subsoil of the former is usually of a sandy nature, while the latter is in most cases clay.

In the northern section, large areas of slough and muskeg lands are covered with a thick growth of moss and semi-decomposed vegetable matter, varying in depth from 18 inches to 4 feet. Under this growth of moss is sand, while in the muskeg in the north-eastern part of the district there is a very coarse gravel underlying the moss.

No surface indications of alkali were evident in the district investigated but numerous soil samples were taken and forwarded to the Dominion Chemist for analysis, in order that a definite report on the probable value of the land after reclamation may be available.

In the southern and western portions of the district, the timber is very light, consisting mostly of scrub willow, in the central portion there is a heavier growth of timber, particularly in township 49, range 12. The growth of timber, however, throughout the district is not heavy and no value of any importance may be attached to it other than its use for firewood and for small buildings such as settlers may require to construct in a new country.

To provide an economical ditch layout, it is proposed to follow the natural watercourses as closely as possible and by constructing intercepting ditches on the north and west boundaries of the district, to divert the water flowing from these directions during the spring freshet to the main canals, thus preventing the flooding of the land within the district. The reclamation of the interior lands will be taken care of by lateral ditches, projected every two or three miles, connecting with the large canals.

The land affected by the project has been classified into three divisions and the road allowances into two, and on this classification has been evolved a basis of assessment in proportion to benefit. The following schedule gives full details of the area and rates of assessment:—

"A" classification, lands	53,828·7	acres
"B" " "	34,608·4	"
"C" " "	12,484.0	"
"D" " roads	388·8	"
"E" " "	1,399·1	"
Total land benefited	102,709·0	"
Total land unaffected or only indirectly benefited	4,536.2	"
Total road allowances unaffected or only indirectly benefited	154.1	"
Total in proposed district	107,399·3	"

Cost per acre of benefited land and road allowances, flat rate $2.57

Cost or assessment per acre of classified lands and road allowances:—

"A" classification, lands	$ 3.24	per acre
"B" " "	1.94	" "
"C" " "	.65	" "
"D" " roads	12.94	" "
"E" " "	6.47	" "

Assessment per dollar of benefit, $0·1294.

Northern and eastern portions contain many open sloughs with poplar and willow on some of the sections. This timber has no commercial value other than for fencing and firewood. A limited quantity of larger timber could be obtained for log houses and barns for use of settlers upon coming into the district.

The soil, generally, throughout the district is exceptionally rich in humus, particularly in the low-lying land where there is from two to six inches of moss overlying a deep layer of humus. The higher land is free from moss and the depth of the humus is much less than on the lower land, while the subsoil is of a sandy nature; this class of land, however, forms but a very small percentage of the tract.

The Dominion Chemist in reporting on soil samples typical of the land in this district states that the soil consists of an excellent clay loam, rather heavy, but well supplied with vegetable organic matter and nitrogen; that its saline content is practically negligible, and that when drained and judiciously tilled it should prove extremely productive and suitable for a large range of farm crops.

The fact that a very considerable number of entries for homesteads through the West Moose Range district have been accepted in past years, when perhaps the want of drainage was not so greatly felt as at present, has restricted somewhat the area that may be included in this project, if it is to be constructed by the Federal Government. It is only possible to include 16,765 acres of which the Crown controls 65 per cent.

Three main ditches have been projected for the district having as a common outlet Bridge creek. A maximum discharge of 117 cubic feet per second has been provided for and the total cost is estimated at $52,000, or a per acre cost of approximately $3.10. This is a very favourable cost for the complete reclamation of fairly "close in" land. The cost was based on a unit price for excavation of 30 cents per cubic yard. Under present conditions, it may be reduced to about 20 to 25 cents per cubic yard, thus reducing quite considerably the relatively low rate of cost per acre previously estimated.

The West Moose Range project presents no engineering difficulties, it is very desirable in the public interest and the investigation very fully indicates its economic feasibility. Construction is recommended.

PONASS LAKE EXTENSION PROJECT

Townships 37, 38, 39, 40, 41 and 42, Ranges 15, 16 and 17, West 2nd Meridian

A complete survey of the Ponass Lake Project was carried out during the season of 1919 by one of the large drainage parties of the Reclamation Service and full particulars were published in the 1920 report of this branch. It was thought that a very considerable area of land adjoining the project as originally defined might, at reasonable cost, be added to it, and with a view to securing full particulars and data a reconnaissance of the Ponass Lake Extension scheme was made last season.

It was found that the area investigated includes two watersheds, the division being roughly in about the northern boundary of township 38, the southern portion being tributary to the Quill lakes and the northern to the Barrier river. This country is rolling and well wooded with a growth of poplar on the high land. Between the ridges which traverse the country north and south are long narrow sloughs of varying depth and containing relatively small acreage.

In general the top soil is good, being from 6 inches to 18 inches of black loam containing much vegetable mould, although many of the ridges show outcroppings of boulders and the subsoil is as a rule, light. In most cases this description also applies to the slough land, although here there is a greater depth of decayed vegetable matter on the surface. Vegetation is good on the high land, where a dense growth of peavine is in evidence, while the slough land shows a good growth of redtop and coarse slough grass. The cultivated land grows oats and barley successfully, but wheat and garden truck are affected by frequent summer frosts.

To successfully reclaim this area it will be necessary to construct a very expensive system of drainage works with Barrier river on the north as the outlet. In view of the comparatively small additional area of land that would be included in the Ponass Lake Project, it was considered undesirable at present to further develop the scheme covered by the extension.

MANITOBA

Whitewater Lake

The draining of this lake, which is situated in townships 3 and 4, ranges 21 and 22, west of the Principal Meridian, was first brought to the attention of the department in 1913, when an application was made to purchase land formerly covered by the waters of the lake. An investigation was made in that year from which it appeared that the scheme was not economically feasible and that the land when reclaimed might be of doubtful value for agricultural purposes. The matter remained in abeyance until 1920, when it was decided to have a further and complete investigation made, for the lake had again become completely filled with water. Soil samples taken from land adjoining and near the lake, that had not been settled upon, indicated the presence of alkali in harmful quantities but it is probable if the water-table in the immediate vicinity were lowered by draining the lake that the value of the land would eventually be raised by the gradual elimination of the salts.

The lake comprises approximately thirty square miles and is contained within well defined shore lines. The surrounding country slopes towards it, forming a saucer-shaped area from which there is no natural outlet.

The soil of the lake bed varies but slightly, the portion under water being a very heavy clay, rather light in colour and similar to the subsoil of the land above the water elevation. Towards the shore the soil becomes lighter and is of a sandy clay nature, while a belt of from 250 feet to 350 feet of very sandy soil is found on the shore. Vegetation in the lake bed is very poor. Nothing but foxtail and weeds grow

and they only sparsely. At the east and west ends the vegetation is rather more pronounced and a rank growth of reeds is in evidence. No hay is made and the settlers in the neighbourhood only use the land for spring pasture; it is claimed by them that the grass has a very injurious effect on the cattle.

The watershed area tributary to the lake is approximtely 305 square miles, about half of which lies to the south, from whence several small creeks, flowing only in the spring, empty into the lake. The run-off is light and of short duration as many small pot-holes and lakes in the hills to the south hold much of the water from that direction, only allowing it to overflow in exceptionally wet years, or in a period of such years. A careful study of this and similar watersheds of which complete hydrometric data are available indicates that an outlet canal capable of discharging a maximum flow of 74 cubic feet per second would be required. The only feasible method of drainage is by a direct outlet. It was found that intercepting ditches would necessitate very heavy excavation and very greatly increased cost.

Two outlets were investigated; one to the east and the other from the west end of the lake, but as the latter proved to be very expensive it was dropped entirely from consideration. The cost of the former is estimated as $583,000, which figures out approximately at $30 per acre of reclaimed land, 19,600 acres being affected by the project. Partly improved farms in the vicinity may be purchased for $25 per acre, while prairie land sells at $18 per acre.

Inasmuch as the analysis of the soil affected showed much harmful alkali to be present, suggesting uncertainty as to the usefulness of the land even after reclamation, and because of the cost of reclamation, it was decided to abandon the project.

PRIVATE DRAINAGE PROJECTS

Under the provisions of the Reclamation Acts of the provinces of Alberta and Saskatchewan and of the Dominion Government Drainage Regulations, areas of vacant Dominion Land not exceeding 1,280 acres where the estimated cost of reclamation does not exceed $5,000, may be reclaimed by drainage without reference to the provisions of the Private Ditches Acts of these provinces, under a simplified procedure which has proved very satisfactory to all concerned.

In each such case an engineer investigates the project to determine its feasibility and desirability, and, if it is the wish of the applicant, works for the satisfactory drainage of the land are designed and staked out. The minimum price for land sold in this manner is now fixed at $5 per acre, but the actual sale price is determined by an official of the department after an examination of the land in its present condition.

Many settlers who realize the benefits of mixed farming are actively interesting themselves in draining small lakes and sloughs and are constructing works to lower the level of these in order that more hay may be obtained. In some instances control works are installed to hold the water on the land for a short period in the spring for irrigation purposes, after which it is let off so as to permit of the cutting and making of hay. This is the cheapest form of drainage project, as it only necessitates the lowering of the water table from one to one and one-half feet below the surface of the land. At a later stage, when the benefits of this partial reclamation have been secured, the settler may, at a slightly increased cost, deepen the ditches and thoroughly reclaim the land so that it may be cultivated for the production of cereals, which requires effective drainage of from three to five feet.

The department is continuing the study of the reclamation and treatment of muskeg land, a problem about which there is very little reliable data at present available. This class of soil, if too intensively drained, becomes relatively valueless for agricultural purposes, breaking up as it does into fine particles resembling sawdust, but, on the other hand, if too much moisture is left on the soil, it is equally

valueless. The Department of Agriculture of the province of Alberta is co-operating with this department in carrying out laboratory and field experiments to ascertain the proper methods of treating this soil after drainage and careful study is being given such means as burning, fertilizing, etc., to improve its physical and chemical properties.

During the field-season of 1920 engineers of the Reclamation Service investigated and inspected 55 private drainage projects, of which 4 were cancelled on voluntary abandonment by the applicants and 6, after investigation, showed that they were not feasible under the provisions of Part I of the Drainage Regulations. During the fiscal year April 1, 1920, to March 31, 1921, 127 applications for private drainage projects were received in the department, but of these and former applications 120 were cancelled, chiefly for non-compliance with the Drainage Regulations, or on voluntary abandonment. It is expected that 25 of the new applications will be investigated during the present field-season and that about 25 projects, authorized and under construction, will require inspection. In each investigation the departmental engineers endeavour to obtain complete data regarding the character and value of the soil within the area, as well as the engineering features of the project, so that the applicant shall not incur needless expense in reclaiming land at excessive cost, or land which would be valueless after reclamation.

INTERNATIONAL WATERWAYS TREATY

The measurement and apportionment of the waters of the St. Mary and Milk rivers was carried out during the past season under the provisions of an interim order made by the International Joint Commission pending a final decision on this important matter. As in previous years, an engineer of the Reclamation Service acted in co-operation with an engineer of the United States Reclamation Service in the measuring and apportioning of the waters and the collecting of data in connection therewith.

INDEX

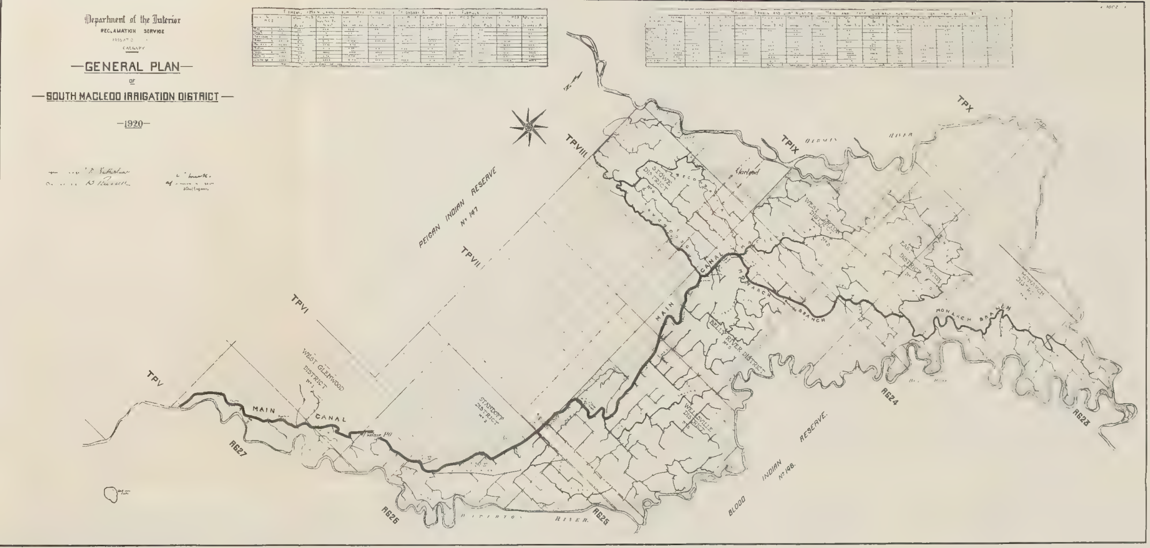
R

S

T

U

W



Department of the Interior
RECLAMATION SERVICE
CALGARY
—GENERAL PLAN—
OF
—SOUTH MACLEOD IRRIGATION DISTRICT—
—1920—
PEIGAN INDIAN RESERVE
Nº 147
TP.V
TP.VI
TP.VII
TP.VIII
TP.IX
TPX
MAIN CANAL
WEST GLENWOOD DISTRICT
STANDOFF DISTRICT
STOWE DISTRICT
WEST MACLEOD DISTRICT
EAST MACLEOD DISTRICT
MONARCH DISTRICT
BELLY RIVER DISTRICT
WELLSVILLE DISTRICT
MONARCH BRANCH
RIVER
BLOOD INDIAN RESERVE.
Nº 148.
RG27
RG26
RG25
RG24
RG23

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Bulletin No. 2, Alfalfa Culture.

Bulletin No. 3, Climatic and Soil Conditions, C.P.R. Irr. Block.

Bulletin No. 4, Duty of Water Experiments and Farm Demonstration Work.

Bulletin No. 5, Farm Water Supply.

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" " Mr. Don. H. Bark: "Practical Irrigation Hints for Alberta"; Extract from W.C.I.A. Report, 1915.

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DEPARTMENT OF THE INTERIOR, CANADA
Hon. CHARLES STEWART, Minister; W. W. CORY, Deputy Minister
Reclamation Service—E. F. DRAKE, Director

ANNUAL REPORT

OF THE

RECLAMATION SERVICE

1921-22

OTTAWA
F. A. ACLAND
PRINTER TO THE KING'S MOST EXCELLENT MAJESTY
1923

One year ago a noisome swamp, 50 acres in area, which when drained produced (as illustrated) a very heavy crop of grain.

DEPARTMENT OF THE INTERIOR, CANADA
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OF THE

RECLAMATION SERVICE

1921-22

OTTAWA
F. A. ACLAND
PRINTER TO THE KING'S MOST EXCELLENT MAJESTY
1923

54354—1½

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS, PLANS, AND DIAGRAMS

RECLAMATION

REPORT OF THE DIRECTOR OF THE RECLAMATION SERVICE, E. F. DRAKE

The unusual climatic conditions to which the semi-arid districts of southern Alberta and Saskatchewan have been subject during the last few years have led to a great demand for surveys to determine what areas it is possible to serve with water, and the work of the Reclamation Service, whose duty it is to make these investigations and surveys, has increased tremendously. The year 1921 brought more demands for advice and practical assistance than any previous year.

CLIMATIC AND CROP CONDITIONS FOR 1921 IN SOUTHERN ALBERTA

Statistics show that the five years just ended constitute the longest consecutive period of subnormal rainfall for many years, and some increase in precipitation may therefore be reasonably expected for the next few years, as periods of drought and abundant rainfall usually occur in cycles.

From December 1, 1920, to the end of March, 1921, the weather was mild with practically no snowfall. This condition was excellent for stock and very little feeding was necessary. Good weather was experienced in April, when light rains occurred, seeding being practically finished by the middle of the month. May was very warm but the rainfall was scanty and there was no reserve moisture in the soil. The month of June was extremely dry, crops being seriously damaged through lack of rain and by hot, dry winds. In July the rainfall was normal, but came too late to save the crops.

IRRIGATED CROPS

Because of light rains during April, which created a good seed bed for the crops, many farmers delayed their irrigating in spite of repeated warnings from the press and irrigation officials, and when the dry, hot weather came in June, the crops on irrigated lands suffered before water could be applied. In spite of this setback, which reduced the yield considerably, the irrigated crops were fair and averaged approximately three times the yield of those on dry land in the same areas. More acreage was irrigated in 1921 by a large number of farmers than in any previous year. The large amount of surplus fodder grown on these lands did much to compensate for the shortage on the adjacent dry lands.

PROGRESS IN IRRIGATION DEVELOPMENT

Corporation Projects.—Development of the large corporation projects has been seriously retarded by the war and the conditions which have existed since. With the return of better times, and a fuller realization on the part of the people of the benefits of irrigation, all indications point to an influx of settlers and the rapid colonization of the available irrigable lands in these projects. The farmers now settled on these lands are every year showing a greater tendency to abandon the system of agriculture to which they have been accustomed and to adapt themselves to the diversified crop system and intensive farming necessary

under irrigation. A large amount of renewal and betterment work has been done during the year and the canal systems of all the projects are reported as being in excellent condition.

Irrigation Districts.—It is probable that corporate irrigation development will be carried on in the future entirely by the district form of organization. The province of Alberta now has an up-to-date and effective Irrigation Districts Act, and a great deal has already been accomplished under its provisions. An Irrigation Council appointed by the province is exercising close supervision over the organization and construction of a number of districts and the machinery provided seems to be running smoothly.

Several districts were organized under this law in 1920, but the first of these to complete its preliminary organization found no market for its irrigation debentures, which were a new commodity in the Canadian financial market. It appeared for a time that further development work by districts must for this reason be indefinitely deferred, but the Provincial Government came to the rescue and by an amendment to the Irrigation Districts Act, passed at its 1921 session, made arrangements to guarantee the bonds of irrigation districts which were favourably reported upon by consulting engineers. This guarantee proved effective and the bonds of this district, as well as those of another organized later, found a ready sale at a fair price and construction work was begun.

These preliminary difficulties having been successfully overcome development work was started. It then became evident to those who were closely studying the problem that many of the individual holdings in the districts were too large to be properly cultivated under irrigation conditions, owing chiefly to the high cost of the works, the inexperience of most of the settlers, and the difficulty of securing a sufficient and dependable supply of skilled irrigators. In order to achieve success in irrigation farming when the cost of the works is fairly high, every acre must be carefully cultivated and made to yield good returns. Generally speaking, the average farm unit should contain from 80 to 160 acres of irrigable land, while the holdings usual in dry farming in this country—and common in the newly organized irrigation districts—run from 320 to 640 acres, or even more. The provincial authorities, foreseeing the difficulties farmers would encounter in redeeming their bonds under such conditions, decided that the larger holdings should be split up, and in 1921 a colonization branch was organized under the control of the Irrigation Council of Alberta. This branch will list the excess land holdings that should be disposed of by the farmers and will carry on a colonization campaign for the purpose of selling these lands and placing additional settlers on them. The practical effect of this effort will be watched with great interest.

Since the Irrigation Districts Act was passed seven districts containing 206,000 acres of irrigable land have been organized; six more containing 35,000 irrigable acres are nearly ready for organization, while five additional projects containing a total of 552,000 irrigable acres are in various stages of preliminary organization.

In Saskatchewan many small irrigation schemes are being operated, but no large co-operative projects have yet been developed. An Irrigation Districts Act very similar to that of Alberta was passed in 1920, but has not yet been used. One project has, however, been surveyed and an irrigation district is now being organized. The Act will therefore probably be brought into practical operation at an early date.

Small Irrigation Projects.—The construction of small individual projects is interesting many farmers whose lands can be irrigated by direct diversion from nearby streams in the semi-arid areas and the waters of some of these streams have been practically all appropriated. Some of these small projects have been

operated successfully for many years and there are at present 483 licensed or authorized schemes, while applications for 228 new schemes were recorded in 1921, making a total of 711 small projects in operation or under construction under the supervision of the Reclamation Service.

Water Users' Associations.—When the development of any large irrigation project or district is completed, the simplest and most satisfactory method of operation and maintenance will probably be by the formation of a number of water users' associations, each consisting of the water users under one or more of the lateral ditches of the project. These local associations, by operating their own systems, can more satisfactorily serve their own requirements and greatly simplify the administration of the whole project. Owing to lack of complete settlement, the time has not yet arrived when these associations are really necessary, but four of them have been formed in the Lethbridge section of the Canadian Pacific Railway Company's projects and are already proving their value.

Irrigation Development Association.—This organization, with headquarters at Lethbridge, was formed some years ago for the purpose of furthering the use of water, aiding in the organization of irrigation districts, and maintaining connections between the farmers and the Dominion and Provincial Governments. The association is still taking an active interest in irrigation development and during 1921 its executive committee presented the case of the farmers of southern Alberta before the International Joint Commission at its hearing in Lethbridge in September.

IRRIGATION IN 1921

During the year 220,000 acres were irrigated in the five large projects now in operation, a satisfactory feature of the season's operations being the large amount of fall irrigation carried on. Construction work was started during the year and is being actively prosecuted on two more large projects, the Lethbridge Northern irrigation district with 105,000 and the United irrigation district with 23,000 irrigable acres. In the United district (south of the town of Macleod) a large proportion of the excavation work and hauling of material is being done by the farmers themselves in small contracts. This lends itself to cheap construction and provides work for men who have no crops of their own to harvest, besides keeping a considerable part of the outlay for construction in the district.

The preliminary surveys for practically all projects—large or small—were made by the Reclamation Service in pursuance of the policy of the Federal Government that the surface water it controls shall be so allocated as to serve the public to the best advantage. In addition to the constructed schemes, surveys have been completed for thirteen other projects which have been found feasible and are now in different stages of organization. Surveys are now being carried on in six new projects and preliminary surveys were also made of several projects which were not found to be feasible or economical and were therefore abandoned.

DUTIES OF THE RECLAMATION SERVICE

It is the duty of the Irrigation Division of the Reclamation Service to administer the surface water supply (with the exception of water powers) in the Prairie Provinces. This is done under the provisions of the Irrigation Act and includes the use of water for domestic, municipal, industrial, irrigation, and other purposes. To administer the water supply so that the greatest benefit may result to the public is a heavy responsibility, and a large staff of engineers and helpers is needed to deal with the many different phases of the work. Because

of the ever-increasing demands for irrigation the work has been growing heavier each year and the present year has been no exception. The work comprises:—

1 Inspections and surveys of small schemes, new or in operation;
2 Supervision of large projects under construction or in operation;
3 Duty of water experiments and climatic studies;
4 Soil surveys and experiments and seepage investigations;
5 Plane-table and final surveys to complete some projects, and location, topographical, and reconnaissance surveys in connection with new projects and the development of reservoir sites.

These surveys and investigations of various kinds were carried on at a number of different points throughout southern and central Alberta and southwestern Saskatchewan. Good progress was made during the season which ended in November, 1921, and during the winter months the engineers and some of the more skilled assistants were employed in the office preparing plans of work done in the field and making the necessary designs, studies, and cost estimates of the different projects. The following schedule shows the development of irrigation up to this date:—

IRRIGATION DEVELOPMENT IN WESTERN CANADA

Project	Source of supply	Area of tract	Irrigable area	1921 Operations: No. of water users	1921 Operations: Area irrigated	Cost of construction up to 1921	Mileage of canals
		acres	acres		acres		
Constructed and in operation—							
C.P.R. West'n sec.	Bow riv.	1,145,336	218,980	875	33,618	$5,116,252 00	1,469
C.P.R. East'n sec.	Bow riv.	1,212,074	400,000	924	88,299	10,924,738 00	2,500
Alberta Ry. & Irr. Co.	St. Mary riv.	434,509	130,000	865	75,550	1,874,601 00	200
Taber irrigation district	St. Mary riv.	30,365	17,244	160	10,352	272,000 00	72
Under construction, partly in operation—							
Canada Land & Irr. Co.	Bow riv.	452,482	202,640	64	9,400	6,473,207 00	355
Under construction, not in operation—						Estimated cost	
Lethbridge N. irr. dist.	Oldman riv.	231,220	105,000	....	....	5,400,000 00	
United irr. dist.	Belly riv.	61,195	23,000	....	....	524,000 00	
Found by surveys to be feasible and economical (dist. organized)							
Macleod irr. dist.	Waterton riv.	108,603	49,649	....	....	2,060,000 00	
Medicine Hat E. irr. dist.	Ross crk.	4,800	2,900	....	....	36,140 00	
Little Bow irr. dist.	Highwood riv.	11,490	3,278	....	....	74,250 00	
Found by surveys to be feasible (dist. not organized)—							
Eyremore irr. dist.	Bow riv.	18,776	4,100	....	....	250,000 00	
River Bow irr. dist.	"	16,688	5,792	....	....	314,357 00	
New West irr. dist.	"	13,015	7,629	....	....	385,000 00	
Lethbridge S.E. irr. proj.	Waterton, Belly, St. Mary, Milk rivs.	1,182,781	390,708	....	....	15,800,000 00	
Robsart-Vidora proj.	Frenchman riv. and Belanger, Davis, Sucker and Fairwell crks.	14,000	10,000	....	....	343,841 00	
Incompletely surveyed, believed feasible—							
Retlaw-Lomond irr. dist.	Bow and Oldman rivs.	418,630	70,000	....	....	2,500,000 00	
Champion irr. dist.	Highwood riv.	184,860	50,000	....	....	....	
Granum irr. dist.	Willow crk.	....	4,500	....	....	260,000 00	
Beaver Crk. proj.	Beaver crk.	....	9,000	....	....	450,000 00	
Surveys commenced—							
N. Saskatchewan irr. proj.	N. Sask., Clearwater, Red Deer and Battle rivs.	3,538,760	1,778,784 (estimated)	....	....	....	
Private schemes (483)—							
Small private schemes	....	....	105,397	....	....	....	
Prospective development—							
Co-operative	....	....	250,000	....	....	....	
Small private schemes	....	....	85,000	....	....	....	
Total	....	....	3,923,601	....	....	....	

WATERWAYS TREATY

The " St. Mary and Milk River Case ", dealt with under the provisions of the Waterways Treaty, and to which reference has frequently been made in earlier reports, has apparently now been finally settled; at all events, it has advanced another stage toward final settlement.

Provision is made in article VI of the Waterways Treaty between Great Britain and the United States for the division of the waters of the St. Mary and Milk rivers, and their tributaries in the state of Montana and in the provinces of Alberta and Saskatchewan, between Canada and the United States in such manner as to recognize to some extent the prior appropriations from these streams in the respective countries, and to ensure approximately equal division of the waters, it being stipulated, however, that more water may be taken by one country from one stream and less from another, without, however, affecting the substantially equal division of the total flow. The case was first considered officially by the International Joint Commission at a public hearing at St. Paul, Minnesota, in May, 1915, at which all the interested parties were represented and considerable evidence was taken. This was followed by arguments by counsel, and later by the filing of written briefs. Again, in May, 1917, a further hearing was held at Detroit, Michigan, where additional arguments were submitted by counsel and, still later, final arguments were heard at a meeting of the commission held in Ottawa in May. 1920.

In the meantime and pending the issuance of a definite order, it became necessary to provide for some method of dividing the waters of these streams so that irrigation development might proceed without serious hindrance. Therefore, on May 24, 1918, the commission issued an interim order describing in considerable detail the methods to be followed by the designated representatives of the United States and Canada, respectively, in measuring and apportioning the waters of these streams and their tributaries during the irrigation season of that year. This order was found to be satisfactory as a temporary expedient. It was therefore renewed by the commission on April 3, 1919, April 7, 1920, and April 6, 1921, in substantially the same terms.

Under these interim orders the Reclamation officers of Canada and the United States continued their measurements of stream flow and apportioned the waters as was found necessary from time to time. No serious difficulties were encountered, but it soon became apparent that no considerable development of irrigation would be possible in either country until the commission made some final order defining the proportion of stream flow that would be permanently assigned to each country. This was particularly the case in southern Alberta, where surveys carried on by the Canadian Reclamation Service had demonstrated the feasibility of irrigating a considerable additional area of land by the utilization of all the available stream flow and the conservation of flood flow whereever possible. It was felt that the actual construction of works of any magnitude would be inadvisable pending a final decision by the commission.

In September, 1921, the commission held further hearings at Chinook, Montana, and at Lethbridge, Alberta, for the purpose, primarily, of giving the locally interested persons an opportunity of presenting their views directly to the commission and to place the commission in possession of any facts which might not have been clearly brought out at any of the earlier hearings or by any of the arguments submitted by counsel.

Following these hearings the commission at its next regular meeting at Ottawa on October 4, 1921, gave an order which for all practical purposes may be regarded as an interpretation of certain alleged ambiguities in article VI of the treaty, and as a final order apportioning the flow of these streams between the United States and Canada, respectively.

On October 6, 1921, the commission made a further order or recommendation addressed to the Governments of the United States and Canada jointly. Realizing that the control of flood water is the crux of the situation, in so far as irrigation development in southern Alberta, southwestern Saskatchewan, and northern Montana is concerned—in so far as this development is dependent upon the waters of the St. Mary and Milk rivers and their tributaries—the commission recommended that the United States and Canada should jointly construct a reservoir for the control of flood waters at St. Mary lakes, in the state of Montana; that the United States should construct the Chain of Lakes reservoir in the Milk River valley below the point where Milk river crosses the international boundary for the last time—this for the more effective control of the flood waters of that stream; and that Canada should construct a reservoir in Verdigris coulee in southeastern Alberta, where it is possible to conserve waters diverted either from the St. Mary or the Milk river. The commission further recommended that these reservoirs, when constructed, should be maintained and operated under its control so as to ensure the most beneficial use possible of the waters.

No action has as yet been taken by either Government to carry these recommendations of the commission into practical effect. It will probably be necessary, before any definite action is taken, to have an investigation made by the engineers of the respective countries, either severally or conjointly, to determine the feasibility, the practical effect, and the cost of carrying the recommendations of the commission into effect. The recommendations are believed to be entirely practicable from an engineering point of view. The questions to be studied have, therefore, largely to do with the size of the several reservoirs, their approximate cost, the manner in which that cost shall be shared—in so far as international co-operation has been recommended—and the manner in which the stored water shall be apportioned to the two countries, respectively.

DRAINAGE

The investigation of reclamation projects during the 1921-22 season by the engineers of the Drainage Division of the Reclamation Service has resulted in the addition of three more projects initiated by the Government to the eleven previously investigated and recommended as feasible and in the public interest, making a total area of approximately 220,000 acres of swamp and submerged lands that can be economically drained and made available for settlement. While the reclamation of this area would provide accommodation for no less than two thousand families, there would be a further and far-reaching benefit in the greater consolidation of the present scattered and uneconomic form of settlement in the vicinity of the projects, in making possible the construction of roads to reach many good farming districts at present unapproachable, thus forming the nuclei of extensive farming communities. The cost of the reclamation works, according to estimates of the engineers, would be more than reimbursed by the sale of the Crown lands and the assessments on the privately owned lands benefited.

These recommended reclamation projects embrace principally such lands as experiment and experience have shown to be the most readily available for agriculture and the growing of hay. Lands requiring considerable expense in clearing of timber, moss, and reeds have been avoided for the present in favour of those more nearly ready for the plough or the growing of hay, except in cases where such clearing is only required on a small proportion of the project.

In addition to the investigation of the above projects, which have been recommended for construction by the Federal Government, surveys of the extensive swamp lands known as the Carrot River Triangle were commenced

in the spring of 1921 and carried on vigorously until far into the winter. This tract lies between the Saskatchewan and Carrot rivers in Saskatchewan and Manitoba and has an area approximating 1,100 square miles. It lies in the direct route of the proposed railway running from Melfort in Saskatchewan to Pas in Manitoba, which when built would connect the grain belts of Saskatchewan and Alberta with the Hudson Bay railway and Port Nelson. Should this project prove feasible, its reclamation would ensure revenue for the railway and the railway would provide the needed transportation facilities for the farming community. Another season's work is required to complete the surveys and investigations, which on account of the difficulty of penetrating the swamps during the open season will probably be again carried on through part of the winter.

Three other projects, initiated by the Federal Government under part 4 of the Drainage Regulations, were investigated but not recommended for reclamation on account of the high cost of construction, the prevalence of deep moss muskegs, the poverty of the soil, or on account of their containing upwards of fifty per cent of privately owned lands and thus coming under the provisions of part 3 of the Drainage Regulations which contemplate the initiation of the work upon petition of the landowners under provincial laws.

Many applications for private drainage schemes under part 1 of the Regulations were received, but when it became known that the minimum price of Crown lands had been increased from one dollar to five dollars per acre, while the area that might be sold to any one applicant was reduced from 1,280 to 320 acres, many withdrew their applications and others who allowed their applications to stand did so under protest. Twenty-five new applications of this class were dealt with and twenty-six inspections were made of those already under way.

The construction of the Waterhen Lake drainage project, initiated by the Government, was commenced in May and the work of excavation was continued throughout the season until the freeze-up in November. Approximately seventy per cent of the excavation was completed. The water of the lake will be let off about midsummer of 1922 and as soon as the lake bed and the marsh dry sufficiently to permit the construction of the bridges, culverts, and small laterals this work will be proceeded with, but it is expected that some of the minor details will not be completed in 1922.

Difficult problems are being encountered in many projects regarding the treatment of various classes of swamp lands after the water has been drained off. Various methods of clearing the land of superfluous accumulations of undecomposed vegetable matter and supplanting coarse wild grasses of low food value by the more valuable cultivated grasses are being adopted by owners of private drainage schemes. While these methods and the results are being carefully noted, it is obviously of the utmost importance and in the public interest that practical experiments should be carried out by the department along scientific lines. The application of artificial and barnyard manures on an extensive scale is quite out of the question in newly settled districts and lands requiring such treatment for their reclamation are for the present being passed over, but experiments of the kind recommended may indicate other practical methods of treatment.

Profitable cultivation of the dry belt in the southern parts of the Prairie Provinces is dependent upon irrigation, and although only a small percentage of the area can be irrigated these favoured areas can be made to produce marvellous crops and to pay a good return on the capital invested. There will, however, always be extensive tracts of unreclaimed land in the dry belt because of scanty water supply and the unsuitability of some land for irrigation. The northern parts, on the other hand, enjoying a greater amount of rainfall, will contain only

a comparatively small percentage of uncultivable lands after the swamp lands have been drained and the timbered areas cleared. While the actually irrigated lands of the south may be more intensively productive, profitable farming lands will be more widespread and general throughout the north, following in the wake of drainage.

In the following pages will be found reports from the Acting Commissioner of Irrigation and from the Supervising Hydraulic Engineer, describing in some detail the work carried out under their immediate supervision during the past year.

REPORT ON IRRIGATION SURVEYS AND INSPECTIONS FOR THE YEAR ENDED MARCH 31, 1922

By V. Meek, A.M.E.I.C., Acting Commissioner of Irrigation and

Chief Engineer

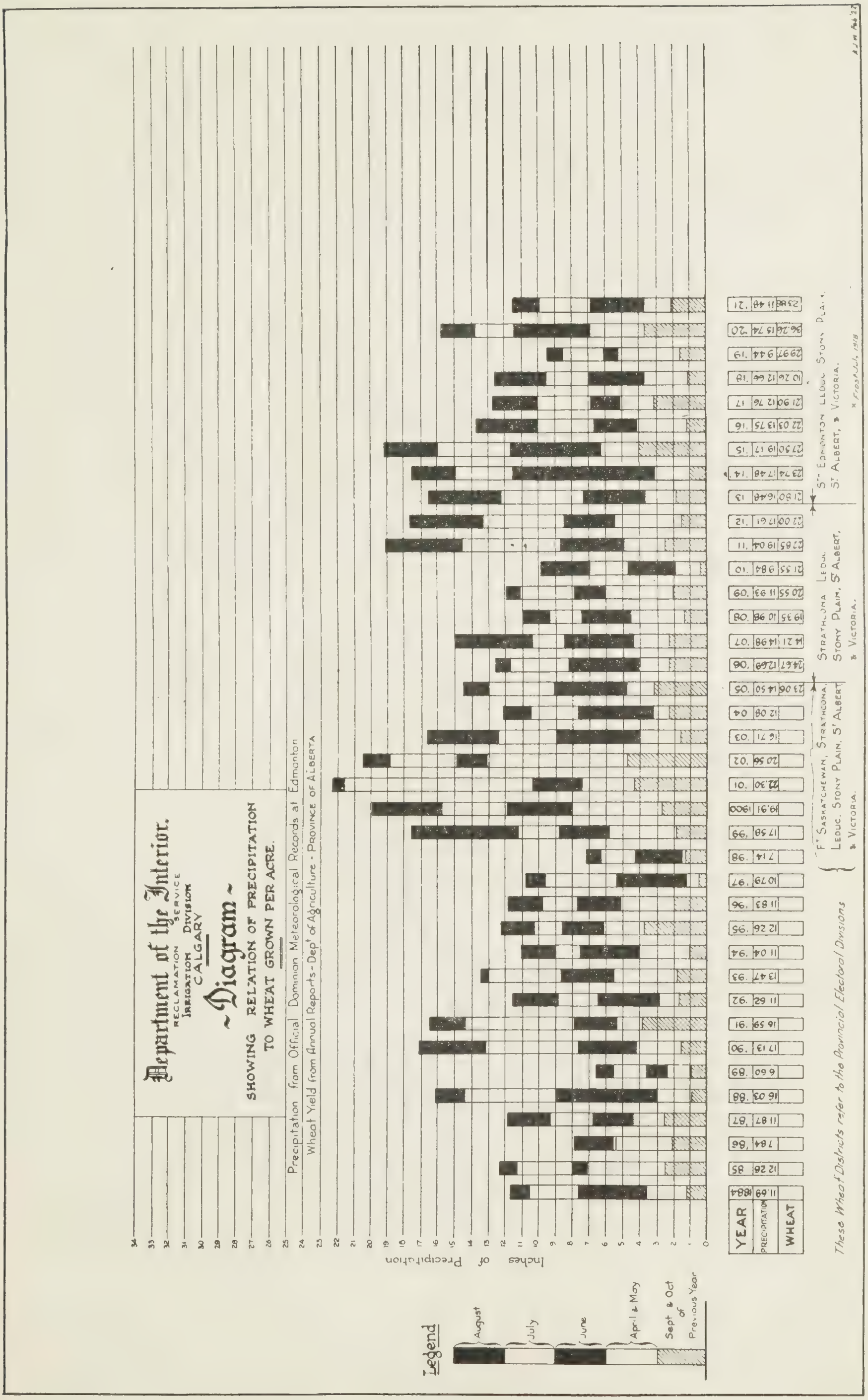
This report contains a summary of the detailed reports of the several engineers in charge of the more important irrigation surveys and inspections. The original reports are on file in the offices of the Reclamation Service at Calgary and Ottawa, and as far as possible the complete information which these contain will be made available to those interested in any particular feature of the work.

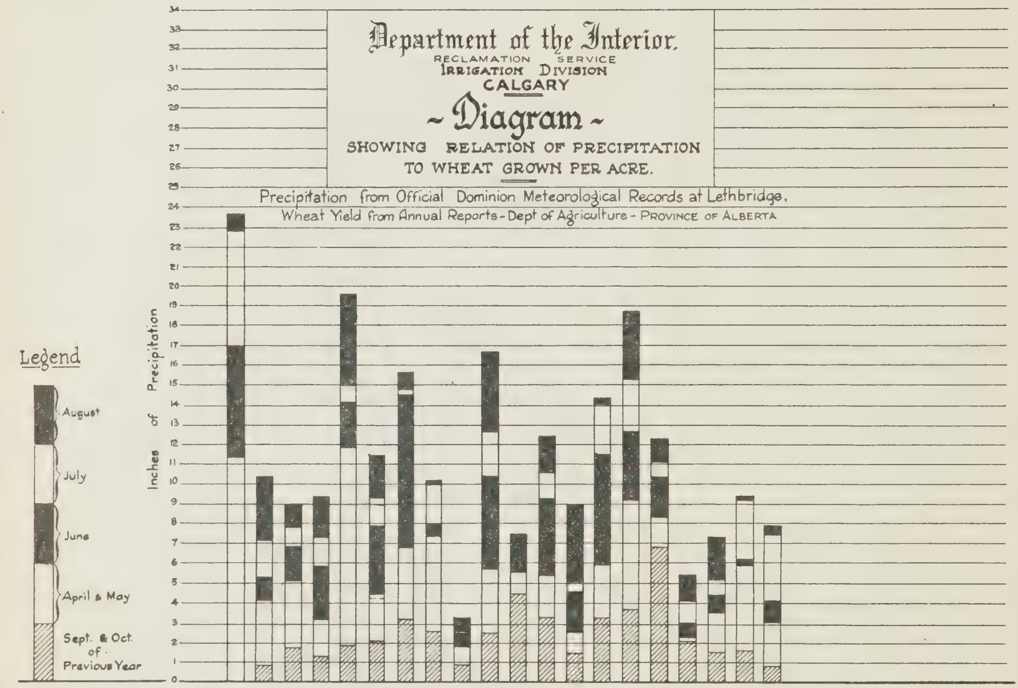
GENERAL

During the past year a considerable portion of southern Alberta again suffered from drought, making the fifth year in succession of less than normal rainfall. As a consequence there has been an increasing demand for irrigation and the construction of works to serve large tracts of land on which dry farming methods have not proved successful. A total of 228 applications for water rights was filed, which is greatly in excess of the records for any previous year.

RELATION OF WHEAT YIELD TO RAINFALL

The graphs on the accompanying pages show the general trend of rainfall and its relation to wheat yields over a long period of years. Unfortunately, the records of wheat yields are not as complete as the rainfall records, but they are extensive enough to show fairly conclusively that there are no definite cycles of either good or bad years. The old adage of " Seven dry years and seven wet years," is entirely disproved. The diagram of the Calgary district covers a period of thirty-seven years and it is apparent that there were fourteen years in which the rainfall of the growing season (April to August) and of September and October of the previous year was less than ten inches, and yet these were by no means years of crop failure. The yield in 1917, for instance, was 25·59 bushels per acre, with a rainfall only just over eight inches. In 1909 the rainfall was only 9·4 inches but the yield was 25·18 bushels. Crop failure is not necessarily due solely to insufficient rainfall in any one year; the seasonal distribution of the rainfall and the effect of preceding years of drought are important contributing factors. Surplus soil moisture is carried over from one year to another in normal years and is supplemented yearly by the seasonal precipitation. From this diagram it is apparent that the period 1917-21 inclusive, has been the driest cycle of the thirty-seven years under review. It may, therefore, be assumed, without undue optimism, that a series of more favourable years may now be expected.


Department of the Interior.
Reclamation Service
Irrigation Division
Calgary
~Diagram~
Showing Relation of Precipitation to Wheat Grown per Acre.
Precipitation from Official Dominion Meteorological Records at Edmonton
Wheat Yield from Annual Reports - Dep't of Agriculture - Province of Alberta
Legend
August
July
June
April & May
Sept & Oct of Previous Year
Inches of Precipitation
YEAR
PRECIPITATION
WHEAT
These Wheat Districts refer to the Provincial Electoral Divisions



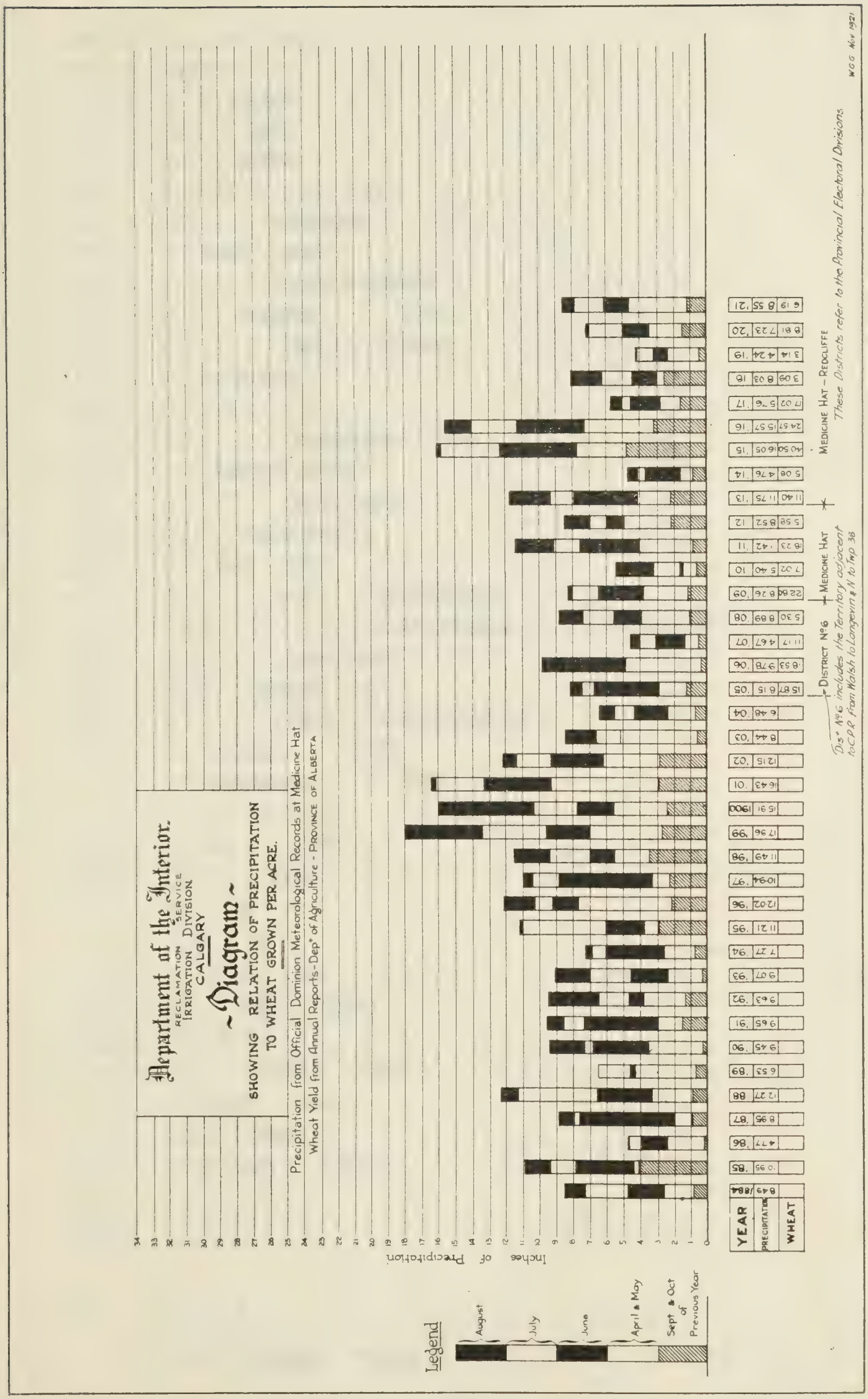
YEAR	1902	1903	1904	1905	1906	1907	1908	1909	1910	1911	1912	1913	1914	1915	1916	1917	1918	1919	1920	1921
PRECIPITATION	23.61	10.33	8.99	9.37	19.67	11.68	15.68	10.18	3.39	16.71	7.47	12.41	9.00	14.39	18.79	12.26	5.42	7.28	9.40	7.88
WHEAT				9.43	21.79	21.34	19.87	20.79	12.19	20.18	16.89	16.12	7.77	40.25	32.42	14.01	7.21	5.30	16.33	9.30

DISTRICT Nº3 — CARDSTON, LETHBRIDGE — LETHBRIDGE, TABER, CARDSTON, WARNER.

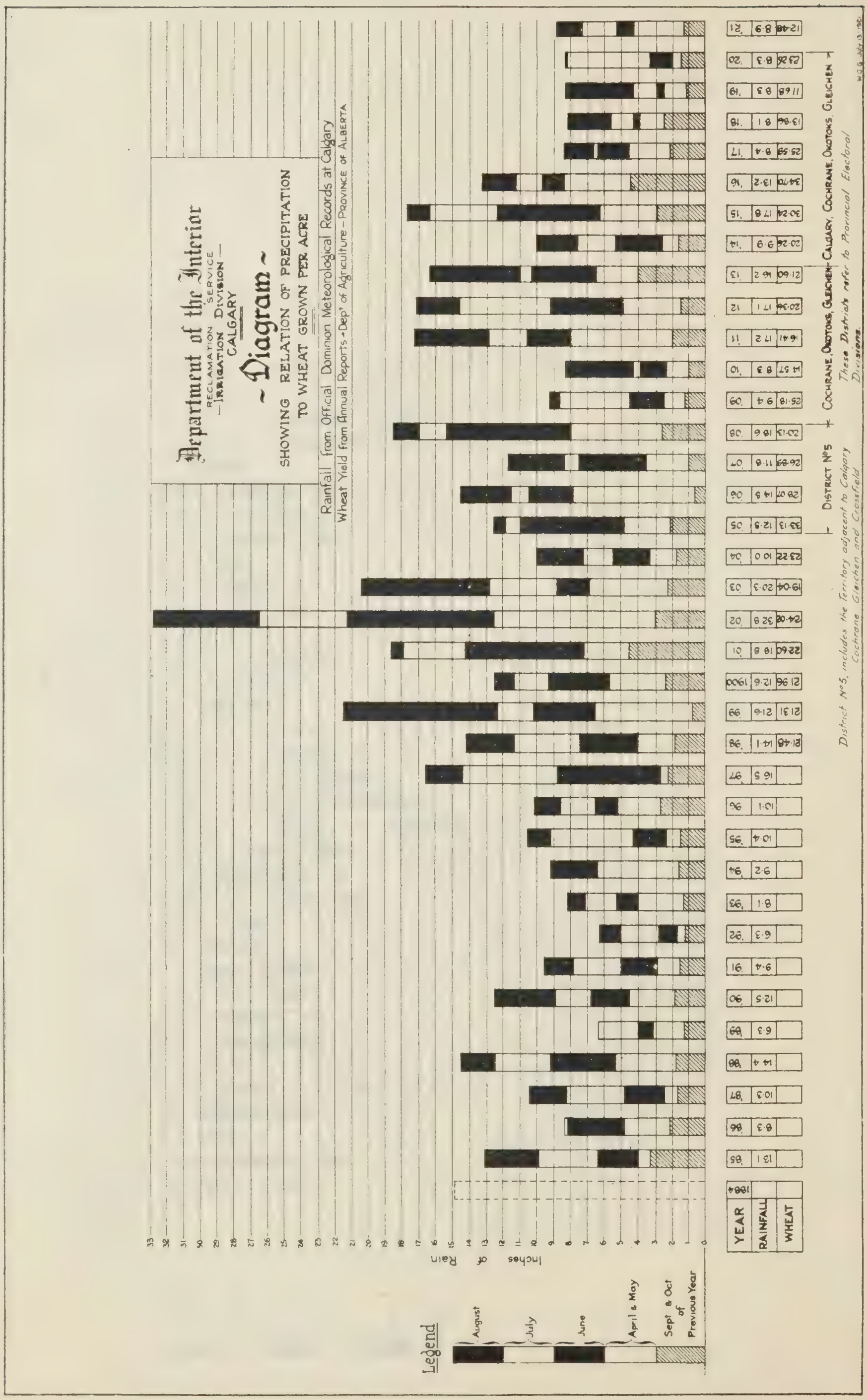
District Nº3 includes the Territory adjacent to Lethbridge, Raymond and Stirling

These Districts refer to the Provincial Electoral Divisions

AJW Nov 1921



Department of the Interior
RECLAMATION SERVICE
IRRIGATION DIVISION
CALGARY
~Diagram~
SHOWING RELATION OF PRECIPITATION TO WHEAT GROWN PER ACRE.
Precipitation from Official Dominion Meteorological Records at Medicine Hat
Wheat Yield from Annual Reports-Dep't of Agriculture - Province of Alberta
Inches of Precipitation
Legend
August
July
June
April & May
Sept & Oct of Previous Year
YEAR
PRECIPITATION
WHEAT
District No. 6
Medicine Hat
Medicine Hat - Redcliffe
Dist No. 6 includes the Territory adjacent to C.P.R. from Walsh to Langevin & N to Twp 38
These Districts refer to the Provincial Electoral Divisions
W.G.G. Nov 1921


Department of the Interior
Reclamation Service
— Irrigation Division —
Calgary
~ Diagram ~
Showing relation of precipitation to wheat grown per acre
Rainfall from Official Dominion Meteorological Records at Calgary
Wheat Yield from Annual Reports - Dep't of Agriculture - Province of Alberta
Legend
August
July
June
April & May
Sept & Oct of Previous Year
Inches of Rain
Year
Rainfall
Wheat
District No 5
District No 5, includes the Territory adjacent to Calgary Cochrane Gleichen and Crossfield
Cochrane, Okotoks, Gleichen - Calgary, Cochrane, Okotoks, Gleichen
These Districts refer to Provincial Electoral Divisions.

The diagram for Medicine Hat district also shows that the soil moisture carried over from the years of ample precipitation is an important factor in the yields of subsequent years. For example, with 15·57 inches of rainfall in 1916 a yield of 24·57 bushels was obtained, and in 1917, although the rainfall was only 5·76 inches, a yield of 17·02 bushels was harvested. The diagram shows clearly the diminishing yields subsequently obtained during a series of years of inadequate precipitation when no moisture was carried over in the soil.

The Lethbridge district diagram covers a period of twenty years rainfall records, but only seventeen with crop yield relationship. From a study of this diagram, it will be apparent that the last four years constitute the longest consecutive period of subnormal precipitation. An increase in rainfall may, therefore, reasonably be expected for the next few years.

From the Edmonton district diagram, it will be noticed that during the past twenty-five years the precipitation for the period affecting crop growth only went below ten inches on three occasions, viz., 1898, 1910, and 1919. In this district there was sufficient moisture carried over in the soil to produce a 21·55 bushel crop in 1910 and a 29·97 bushel crop in 1919.

The studies in connection with these diagrams would have been incomplete without the aid of the report on "The Temperature and Precipitation of Alberta, Saskatchewan and Manitoba," by A. J. Connor, M.A. published under the direction of the Director of Meteorological Service at Toronto.

The value of rainfall and temperature records in connection with the development of the farm lands of the West cannot be over-emphasized and the number of stations could with advantage be considerably increased. The southern portions of the provinces of Alberta, Saskatchewan and Manitoba, which have suffered from drought during the past few years, are badly in need of additional meteorological stations.

ORGANIZATION

The organization of the staff was similar to last year except that a larger proportion was employed in the office to complete the immense amount of detail work in connection with the design and estimates for the proposed Lethbridge Southeast project.

WATER ADMINISTRATION

Increasing Demand for Water Rights.—From the enactment of the Irrigation Act in 1894 to the end of the 1917 applications for water rights were filed with the Commissioner of Irrigation at an average rate of seventy per annum. The urgent demand for irrigation within the last few years has had a very marked effect on the work of this office as shown by the number of applications filed, thus:

1917	60
1918	73
1919	177
1920	196
1921	228

The cumulative result of this increasing and sustained demand for water rights has fully demonstrated the wisdom of steps which were taken in 1915 to devise a standard method of controlling diversions on an equitable basis before water supply conditions reached a critical stage. The revision of existing water rights on this basis is a continuous process. Each new appropriation tends to enhance the value of old priorities which must be fully protected in

considering the proposals of new applicants. The total number of appropriations filed up to the end of 1921 was as follows:—

Licenses	783	
Permits	26	
Authorizations	246	
Schemes under investigation	409	
		1,464
Cancellations		798
Total		2,262

The five largest filings represent a total irrigable area of 1,065,000 acres. The issue of authorizations is now proceeding at a rate much in excess of previous records.

Water Administration Maps.—Seventy-one maps have now been completed and thirty-one draft sheets are in process of compilation. These maps are an essential part of the records and must be kept up to date, to show graphically the standing and progress of each irrigation or water supply project.

Standard Period.—In order to secure consistency in estimates of run-off it has been decided to tentatively adopt the period 1911 to 1920 inclusive as a standard decade. The assumption that this period will give a true normal is based on a comparison with long term precipitation records at Calgary, Medicine Hat, Edmonton, Qu'Appelle, Grenfell and Swift Current. The general averages for Alberta and Saskatchewan respectively show that the average precipitation for the standard decade is essentially the same as that for the full periods available, ranging from thirty-five to thirty-eight years. As far as practicable, estimates of water supply will be made from hydrometric records for the standard period or correlated with similar records covering this period. This procedure will not obviate the necessity for continuing existing gauging stations but will facilitate comparative studies and simplify future adjustments if they are found to be necessary. It is a coincidence that this particular decade appears to correspond more closely than the past twenty years with the assumed true normal over thirty years. A large proportion of the hydrometric records are available from 1911 and, speaking generally, it may be stated that the year 1920 approximates fairly closely to the general average for the total run-off in most localities.

The discovery of these relationships has removed one of the principal difficulties encountered in preparing the run-off maps referred to in the last report.

License Fees.—A uniform charge of $10 has heretofore been made on the issue of all water licenses irrespective of the quantity of water granted, but in order to cover the cost of the clerical work involved in dealing with licenses for large projects the regulations have been amended to increase the charge for all grants requiring more than 1,500 acre-feet of water. The fee for a license to divert up to two acre-feet for domestic purposes has been reduced to $5. Individual users under the larger projects hold their water rights by virtue of water agreements recorded and filed with the Commissioner of Irrigation. The registration fee is twenty-five cents for each record whether filing, transfer, or cancellation. The fee for a temporary permit under Section 20-F of the Irrigation Act is $5 and for the transfer of an ordinary water right, $3. The value of any water right is, of course, much in excess of the fee charged, but the cost of investigational work is properly chargeable to the community at large, as the development of irrigated areas increases the value of surrounding lands and promotes the general prosperity of any locality or district where irrigation is practised.

Duty of Water.—As a development from the earlier practice of a uniform duty, many grants are now being made according to estimates of the quantity which can be applied to beneficial use. The principle is obviously sound, but considerable discretion and knowledge of local conditions is necessary to determine the precise quantity of water available and required in particular cases. It has been found that three classes of rights are all that is necessary, viz., those based on depths of eighteen inches (the legal duty), twelve inches and eight inches respectively. Other things being equal, it is usual to allow eight inches for flood rights, twelve inches when both high and flood water are available and eighteen inches depth when water is normally available at all stages.

Climatic Studies.—In determining an appropriate duty of water for any particular scheme it is necessary to know the average precipitation for the year and for the growing season, as well as the monthly temperatures which indicate the period when water can be applied most beneficially. These investigations have been very much facilitated by the publication of a report already referred to, on "The Temperature and Precipitation of Alberta, Saskatchewan and Manitoba." This report contains a valuable series of maps based on correlated records for a thirty-year period and is in constant reference for study purposes.

Soil Investigation.—The questions of soil texture and composition are closely associated with the granting of water rights, as a porous soil needs more water than an impervious clay, and whenever alkali occurs within a few feet of the surface it is necessary to strictly limit the application of water. Since 1914 chemical and electrical tests of alkali soils have been systematically made. Operations during 1921 included the taking and testing of 633 "soil groups," as compared with a total of 1,516 such groups during the previous seven years. Each group comprises four specimens taken at regular depths down to five feet. Sound judgment is necessary to decide where each group should be located and to interpret the results of the analysis. Four electrolytic "bridges" are in field use for this work and have given excellent service.

Adjudication of Water Rights.—Section 46 of the Irrigation Act provides as follows:

> 1. When any licensee abandons or ceases to use or wastes any water to which his license entitles him and any charge of such abandonment or ceasing to use or wasting water is made to the Minister such charge may be inquired into by him or by any person or officer appointed by him for that purpose.
>
> 2. The Minister, if he deems just and proper, may by order declare a forfeiture of the license and the license so ordered or declared to be forfeited shall be cancelled and shall cease and determine. 61 V., c. 35, s. 33.

It is known that certain licensees who have been granted the right to irrigate considerable areas have not fully developed their works and are not using them to full advantage. While no official action has yet been taken towards partial cancellation of the water rights of such licensees, their operations are being closely observed and studied, so that we may be in a position to make appropriate recommendations when the need arises. In case any partially used rights should prevent the further appropriation of water, or in the event of charges of non-use being made to the minister, it will be necessary to hold investigations or adjudications under the above section and to reduce the grants to conform to the use that is being made of them.

Economic Duty.—In cases where the available water supply is inadequate to irrigate the entire area of irrigable land it is necessary to consider the most economical depth to be applied.

Recent experiments at Brooks and elsewhere indicate that soil of high fertility requires a comparatively small depth of water to produce the best crop yields. However, as the quantities stated in licenses are the limits of legal diversion and the present regulations only recognize "beneficial use" it is necessary to proceed with considerable caution before recommending any further changes in the established practice of granting water rights. The present trend of thought amongst irrigationists is towards the full recognition of an economic duty and the available records are being very carefully studied to determine to what extent and in what manner this view can be officially recognized in the granting of future water rights and the revision of existing grants with special reference to vested interests.

Watermasters.—The watermaster for the Cypress Hills district made his annual inspection of Battle creek during the critical period in July 1921 and controlled the diversions in co-operation with the irrigators in this locality. Owing to several complaints of water shortage in the Cardston district it was necessary for the inspecting engineer for that district to promptly investigate these cases and he has since been authorized to act as a watermaster for the portion of the Oldman River Drainage Basin within this district. The large number of authorizations now being issued will doubtless necessitate the further extension of this service at an early date. Very complete instructions have been prepared for the guidance of watermasters in enforcing the law, but it has so far been unnecessary in any case to take legal proceedings under the Irrigation Act or regulations. Prompt action is essential in disputes over the use of water, and the rulings of our officers have been accepted without demur as soon as the requirements of the department have been explained to those in default.

The number of inspections required annually is increasing from year to year. A large proportion of the inspections last season had to do with new applications involving a considerable number of surveys and plans. The inspections required in connection with new applications are, as a rule, given preference and this at times necessitates neglecting some of the older projects already in operation. Last year in one or two of the districts it was found almost impossible to keep up with the new work. In this connection it must be borne in mind that the conditions of water supply are becoming critical in many drainage basins and that field investigations are becoming more exacting.

The annual inspection of operating schemes is to the mutual advantage of the department and the irrigators. The irrigators receive the benefit of the inspecting engineers' advice and co-operation, the engineers add to their fund of irrigation engineering knowledge and thus better fit themselves to judge of the relative merits of the various methods of construction and operation.

On many streams all the low water and in some cases all the high water has been fully appropriated, although the records may show a considerable amount still available during the short period of flood flow. New applications on streams where these conditions obtain, are often difficult to deal with as prior licensees are apprehensive of impairment of their rights should such applications be granted. These conditions call for increasing vigilance on the part of the inspecting engineers to ensure that licensees on critical streams confine their diversion operations strictly in accordance with their grants.

District Offices.—Two district offices were established last season for the use and convenience of district engineers and the public, one at Medicine Hat and one at Lethbridge. This arrangement has proved very satisfactory and these offices will be maintained next season.

Domestic Water Supplies.—The riparian right of a land owner permits the free use of water for domestic and stock-watering purposes, but does not include the right of diversion. If water is to be diverted by means of a dam, flume, pipe, ditch, channel or other means requiring the construction of works, such

diversion can only be legalized by securing authority therefor under the Irrigation Act. This applies to the numerous small reservoirs built by settlers to impound water from the spring run-off.

The inspecting engineers therefore advise settlers who have constructed such reservoirs to secure rights under the Irrigation Act, and explain to them that although in most cases the existence of the reservoir may not at the moment interfere with other rights, there is always the possibility of new-comers filing applications for the right to divert and store above or below them—which, if granted, might entirely deprive them of their usual supply of stored water and of the legal right of obtaining such water in future. An estimate of the cost of filing such memorials and plans is generally given at this time together with an outline of the procedure to be followed. In most cases the total cost does not exceed $15, i.e., $5 for license and $10 for survey and plans. Advertising is as a rule waived, and the filing of plans may also be waived at the discretion of the minister.

Municipal Water Consumption.—Records of the average daily water consumption in imperial gallons for the principal towns and cities of Alberta and Saskatchewan have been tabulated for the years 1915-1921.

The city of Calgary has been omitted as the records were not available. The town of Carmangay has also been omitted for the year 1921 as the water supply system there has been inoperative for a portion of the year, due to the failure of their dam in Little Bow river. The average daily water consumption for all purposes is available for the city of Prince Albert for the year 1921 only.

CITIES AND TOWNS IN THE PROVINCE OF ALBERTA—RECORD OF AVERAGE DAILY WATER CONSUMPTION IN IMPERIAL GALLONS FOR YEARS 1915-16-17-18-19-20-21

Average for the Year	Per head Domestic	Per Head Industrial	Per Head Other Purposes	Per Head All Purposes	Unaccounted for	Per Head Domestic	Per Head Industrial	Per Head Other Purposes	Per Head All Purposes	Unaccounted for	Per Head Domestic	Per Head Industrial	Per Head Other Purposes	Per Head All Purposes	Unaccounted for	Per Head Domestic	Per Head Industrial	Per Head Other Purposes	Per Head All Purposes	Unaccounted for
	Edmonton					Lethbridge					Medicine Hat					Redcliffe				
1915	46·0	31·0	3·0	80·0	....	81·4	32·2	1·5	115·1	....	181·0	28·0	15·0	224·0	....	31·1	6·8	....	37·9	....
1916	52·5	20·7	5·7	78·9	....	116·0	41·3	0·7	158·0	....	214·0	....	....	214·0	....	36·8	22·1	1·0	59·9	....
1917	56·3	25·0	9·7	91·0	....	95·0	55·0	....	150·0	....	257·0	....	....	257·0	....	42·5	30·3	....	72·8	....
1918	58·0	26·2	10·1	94·3	....	102·2	44·7	3·0	149·9	....	....	....	....	264·0	....	66·4	22·4	....	88·8	....
1919	56·7	24·6	9·7	91·7	....	78·1	26·9	....	107·3	....	....	....	....	234·0	....	79·1	13·7	....	92·8	....
1920	54·7	23·4	16·2	94·3	....	91·8	35·1	°6·8	129·1	....	....	....	....	206·8	....	67·9	16·2	....	84·2	....
1921	54·6	23·4	16·8	94·8	....	94·2	27·8	1·4	123·4	....	....	....	....	175·3	....	65·7	9·6	0·46	75·76	....
	Bassano					Carmangay					Athabaska									
1915	6·5	60·2	....	66·7	....	41·9	....	2·0	43·9	....	14·3	....	....	14·3	....	....	....	....	....	....
1916	....	....	....	....	....	32·6	....	....	32·6	....	10·9	....	....	10·9	....	....	....	....	....	....
1917	17·9	154·3	95·4	267·6	....	31·3	....	....	31·3	....	24·0	....	....	24·0	....	....	....	....	....	....
1918	....	....	....	211·0	....	29·8	....	1·0	30·8	....	27·6	....	....	27·6	....	....	....	....	....	....
1919	....	....	....	194·7	....	32·5	....	1·2	33·7	....	26·1	....	....	26·1	....	....	....	....	....	....
1920	....	....	....	158·9	....	26·2	....	*3·4	30·3	....	44·3	....	....	44·3	....	....	....	....	....	....
1921	....	....	....	137·8	....	....	....	....	....	....	33·3	....	....	33·3	....	....	....	....	....	....

°4 months. *7 months.

CITIES AND TOWNS IN THE PROVINCE OF SASKATCHEWAN—RECORD OF AVERAGE DAILY WATER CONSUMPTION IN IMPERIAL GALLONS FOR YEARS 1915-16-17-18-19-20-21

	Regina					Saskatoon					Moose Jaw					North Battleford				
1915	55·0	7·5	0·1	62·6	....	21·6	13·9	2·2	45·6	7·9	24·1	4·6	....	28·7	....	6·6	1·3	2·7	14·8	4·2
1916	66·1	7·8	....	68·9	....	21·0	15·4	1·9	52·6	14·3	35·2	12·3	....	47·5	....	9·5	2·0	4·9	22·7	6·3
1917	59·2	12·6	0·3	72·1	....	24·4	15·6	5·8	66·4	20·6	45·8	13·1	....	58·9	....	10·2	2·2	4·0	23·1	6·7
1918	56·9	11·1	0·1	68·1	....	27·1	17·2	2·4	63·1	16·4	31·6	15·4	....	47·0	....	10·0	4·8	3·0	26·3	8·5
1919	42·8	8·3	....	51·2	....	28·0	16·3	1·9	64·1	17·9	24·8	15·1	....	39·9	....	11·5	1·6	4·4	29·7	12·2
1920	48·9	9·1	*0·9	58·8	....	29·4	14·3	6·1	74·1	24·4	24·5	14·5	....	39·1	....	11·3	5·8	5·9	34·0	10·9
1921	49·6	10·12	2·1	62·56	0·74	29·5	20·3	1·05	72·05	21·2	30·9	3·9	6·2	41·0	....	9·7	2·8	2·9	26·7	11·3
	Weyburn					Estevan					Kamsack					Kindersley				
1915	17·4	....	0·4	17·8	....	9·5	7·1	1·5	18·1	....	....	....	....	....	....	4·9	8·4	1·6	14·9	....
1916	16·9	....	0·3	17·2	....	8·2	5·7	1·0	14·9	....	....	....	....	....	....	5·5	26·8	....	32·3	....
1917	30·1	....	....	30·1	....	9·7	5·5	4·3	19·5	....	....	....	....	....	....	5·8	44·4	....	50·2	....
1918	26·4	....	....	26·4	....	9·3	0·7	7·2	17·2	....	31·6	66·3	....	97·9	....	6·0	8·9	....	14·9	....
1919	25·5	....	....	25·5	....	9·6	2·9	....	12·5	....	....	....	....	....	....	7·8	....	....	7·8	....
1920	30·2	....	....	30·2	....	9·3	4·4	....	13·7	....	....	....	....	....	....	6·9	*17·5	....	21·5	....
1921	27·1	....	....	27·1	....	6·1	4·7	2·0	12·8	....	50·4	724·9	....	775·3	....	8·5	11·01	....	19·51	....
	Prince Albert																			
1921	....	....	....	83·0	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....

EAST CYPRESS HILLS DISTRICT

The boundaries of this district as altered at the beginning of 1921 include all that portion of Saskatchewan lying south of township 17 and west of range 11. Mr. M. H. French, A.M.E.I.C. was again in charge of this district. The season's work comprised 168 actual working days between May 5 and November 21. Sixty-eight inspections, twenty-nine surveys, twenty-nine stream gaugings and thirty-seven miles of traverse were made. Data were gathered regarding three domestic water supplies.

The regular inspection work comprised only a portion of Mr. French's duties. All right-of-way surveys in the several inspection districts were made by him; he also acted as watermaster for this district and made several special investigations not included in the regular programme of inspections, one of these being a reconnaissance of the Maple Creek valley to obtain information preparatory to the detailed survey later carried out by Mr. Hawkins' party.

Mr. French comments briefly on this investigation as follows:—

"The very heavy alkali nature of the soil of the proposed Maple Creek project precludes all hope of any material immediate development. More definite information of the effect of irrigation water upon the productivity of this soil is necessary before the construction of irrigation works would be justified. Steps are being taken to obtain this information, but several years must elapse before it will be complete and available for use.

There are one or two reservoir sites surveyed by Mr. Hawkins which will probably be inexpensive to construct. The material benefits that will result from the midsummer applications of stored water are so evident that some steps towards utilizing these reservoirs may be expected soon. The matter has been discussed with several irrigators in the valley who appeared favourably disposed towards storage. The greatest obstacles to immediate action are lack of leadership, extensive land holdings, large outside interests and dearth of ready cash. The last has been further aggravated by the drop in prices of agricultural products."

Mr. French also made a hurried reconnaissance of the Johnstone Lake Drainage Basin with a view to obtaining a general idea of the need and possibilities of irrigation in that district. The following extract from his report summarizes the conclusions reached as a result of this investigation:—

> "Considerable valley land can be served by spring flooding, but the limited storage facilities will be a handicap to any extensive irrigation development. The valley soil is very heavy and retentive of moisture and produces excellent crops with moderate rainfall. The need of irrigation for grain is not sufficiently urgent to warrant a high expenditure per acre for works. However, there appear to be several places where flood irrigation might be justified and there is one small reservoir site in the valley of Wood river, just south of Gravelbourg, that seems quite promising. No one interviewed seemed interested in irrigation or felt any great need for it. The district about Gravelbourg appeared prosperous in spite of one of two bad years. In view of these conditions in that vicinity and the great demand for assistance in the drought stricken areas of the extreme southwestern portion of Saskatchewan and southern Alberta, it would be advisable to defer further investigation in the Lake Johnstone district and to concentrate on the more needy districts."

Mr. French also gave general supervision to surveys and investigations made during the year by Mr. Hawkins and party in connection with the proposed Robsart-Vidora irrigation district. The office studies of this project were completed during the winter and a detailed report submitted.

CYPRESS HILLS DISTRICT—WEST

The boundaries of this district were altered at the beginning of 1921, its new limits being the 4th meridian on the east, the west boundary of range 16 on the west, the north boundary of township 16 on the north and the international boundary on the south.

Mr. C. H. Moore was again in charge of this district. Prior to the opening of the field season for inspection work, his services were loaned to the Dominion Water Power Branch for the collection of early run-off data in that portion of his inspection district in the vicinity of Pakowki lake. He was engaged on this hydrometric work from early in March to May 7, when his inspection work began. The last sixteen days of the field season were spent in further investigation of the proposed amended Medicine Hat Southern and Medicine Hat Eastern irrigation districts. The season's work comprised 164 actual working days between May 7 and December 12, during which 124 inspections and 41 surveys were made. Information concerning 7 wells and 8 domestic water supply schemes was obtained.

The following extracts from Mr. Moore's report are of interest:—

> "The past year was the fifth successive dry year and farmers now realize the advantages of irrigation. Consequently wherever they believe any water is available for use they apply for it. Several applications have been made for permission to divert water from coulees whose sole supply is derived from drifted snow, and a number of applications have been received for the diversion of water from streams whose flow has already been fully appropriated.
>
> "The number of authorizations granted in this district was small. The only perennial streams in the district are the Milk and South Saskatchewan rivers. Diversions from either source are usually effected by pumping and generally involve comparatively large expenditures. Practically all the flow of the other streams has been appropriated, especially in the southern portion of the district. Most of the licensed schemes have been maintained in good repair and wood structures are in some cases being replaced by concrete.
>
> "Direct diversion schemes were operated from the last week in March until there was no more water to divert, which in most cases was the middle of May. From such irrigations alfalfa yielded an average of two tons, blue joint hay one ton, and wheat seventeen bushels per acre. On dry land there was no yield from alfalfa or blue joint hay, while wheat produced an average of four bushels per acre. With the exception of the higher portion of the Cypress hills and an odd small area in other parts of the district, farming on dry land did not pay during the past season. Large areas of grain were destroyed by cutworms and much of that surviving this pest was killed by the hot winds which commenced about June 22.
>
> "In this district the standard eighteen-inch duty of water cannot be beneficially applied in the short time during which water is available. Until recently all grants for irrigation purposes were made at the full legal duty, and although it may be possible to use only a part of this amount beneficially the whole of it is registered against the stream and that portion which by virtue of conditions cannot be applied is theoretically not available for grant to future applicants. The regulations now permit of making grants at increased duties when the conditions justify such action."

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CARDSTON DISTRICT

In the spring of 1921 this district was altered to comprise that portion of the province of Alberta lying west of range 16 and south of township 17. This change and reduction in area was necessitated by the great increase in the volume of inspection work during the past few years.

Mr. W. Wotherspoon, A.M.E.I.C., was in charge of the district. The season's work comprised 167 actual working days between May 21 and November 19, during which 119 inspections, 44 surveys and 46 miles of traverse were made.

In order to arrive at the total number of inspections made in the entire district, there must be added 16 made by Mr. J. E. Jaffary and 86 by Mr. R. S. B. Lillico. Thirty-five of the latter were separate investigations of individual pumping schemes in connection with the Little Bow irrigation district. The remaining 51 made by Mr. Lillico were applications in the neighbourhood of Lethbridge which were somewhat isolated from the bulk of the other inspections in the district. The number of inspections made in this district in 1921 therefore totals 221.

Most of the irrigation projects in this district are in the foothills, which is essentially a stock-raising country, and the bulk of the irrigable land is devoted to the growing of fodder crops. Those projects which were in efficient operation used water to good advantage last season.

Interesting points brought out in Mr. Wotherspoon's report are contained in the following extracts:—

"Full benefit has in many cases not been obtained by irrigators owing to the delay in operation until the season is too far advanced and the creeks have become too low to enable a full water supply to be diverted. During recent years, on many streams, the duration of flow sufficient for irrigation has been short and it is important that irrigators should remain on their farms and make full use of their ditches early in the season when water is usually available.

"An instance of this was noticed where one ditch serves two irrigators. One irrigator was away from home during the month of June, 1921, and made no use of the available supply. The other used water during fourteen days in June with splendid results. When the absentee returned to his farm, early in July, the water in the creek was too low for irrigation and consequently his hay crop was a failure. This man now realizes the mistake he made, as he stated that 'for every $5 I made by working while away from home I have lost $50 by not being at home to make use of my ditch during June.' "

SPECIAL INSPECTIONS—ALBERTA DISTRICT

The boundaries of this district were somewhat changed from previous years and now include all of the province of Alberta north of township 16. Mr. F. R. Burfield, A.M.E.I.C., was again in charge of this district. The season's work comprised 182 actual working days between May 4 and December 16 during which 80 inspections and 25 surveys were made.

In his report Mr. Burfield, discussing the attitude of the irrigators resident in his district, points out the significance of the personal element as being the

preponderating factor in the success or failure of irrigation projects. He also discusses the manufacture and installation of suitable pumping machinery. Extracts from his report dealing with this matter are quoted hereunder:—

> "There appears to be an opportunity for manufacturers to put on the market a type of centrifugal pump more suitable for irrigation purposes than any of the stock types at present offered for sale. Many of these, as far as can be ascertained, reach their maximum efficiency for normal delivery at a lift of over fifty feet, which is about the extreme limit of economical pumping for irrigation. To obtain the maximum efficiency of these pumps for heads of thirty feet or less it is necessary to run them slowly, with the result that a much reduced discharge is obtained; for this reason it is often desirable to use a larger pump to deliver a specified quantity of water against a low head than is needed against a higher one. This increases the capital cost, the great stumbling block in the way of prospective irrigators.
>
> "Applications for irrigation rights have shown a tendency during the past season to extend somewhat beyond the limits of the dry belt. In this connection it is interesting to note that of all the operating projects visited last season the one found in the most efficient condition was outside of the semi-arid area, in the vicinity of Sedgewick, Alberta."

SPECIAL INSPECTIONS,—SASKATCHEWAN DISTRICT

By a rearrangement of the district boundaries inaugurated at the beginning of 1921 this district now comprises all the province of Saskatchewan exclusive of the East Cypress Hills district. The projects are rather widely scattered, being for the most part industrial supplies for railway companies and domestic applications. The inspection work was carried out by Mr. J. E. Jaffary by train and livery.

The field season extended from April 24 to October 30. In addition to this, two special trips were made in December in connection with inspections for ice cutting permits. The season's work comprised 122 days in the field; a total of 75 inspections and 9 surveys were made.

The following extracts from Mr. Jaffary's report are of interest:—

> "The applications in the Saskatchewan Special Inspections district are, for the most part, made by railway companies, for industrial water supplies. The water supply in many parts of the district is precarious and any schemes whereby water is impounded in coulees, or reserved from springs for use of those in the vicinity should be encouraged. Precaution must be exercised when water is to be used for household purposes, as in some cases much of the run-off stored comes from rather contaminated sources.
>
> "The Provincial Government is actively interested in the water supply in these districts, as is evidenced by the numerous applications being made for reserving the water of springs and the assistance given to municipalities and larger districts. An example of the latter is the formation of the Saskatchewan Water Supply Commission for the purpose of investigating the possibilities of bringing water from the South Saskatchewan river to serve, in addition to the cities of Moose Jaw and Regina, the rural communities along the route of a proposed pipe line. While the votes of the rural population defeated this measure last year, it is still a very live question in the areas affected and will doubtless be reintroduced at some later date.
>
> "The irrigation projects are not numerous due perhaps to the fact that the southern part of the province is blest with a good supply of water,

and also that it has enjoyed fair crops in the dry years and has not had to look to irrigation methods for moisture. The very hot winds that do so much damage in southern Alberta are not encountered to the same degree in this district and sufficient moisture is usually available for crop needs. Irrigation works for forage crops are the only ones in operation."

CANADIAN PACIFIC RAILWAY COMPANY'S IRRIGATION PROJECTS

Western Section.—The Western Section of the Canadian Pacific Railway Company's Bow Valley irrigation project includes about 1,000,000 acres of land of which 218,980 acres are classified as irrigable. To serve this area 1,469 miles of canals have been constructed. During the year an unusually large programme of maintenance and betterment work was carried out; 813 structures were entirely rebuilt and 573 were re-conditioned. This work was done mostly on timber structures which had been in service from ten to fifteen years.

The company now has in use in this section six "D.N.R." excavators, or ditch cleaning machines. These are mechanically operated and clean out ditches up to eight feet in bed width while the water is running and without interfering in any way with the operation of the system.

Approximately ninety per cent of the land in this section has been sold and most of the settlers are now well established with substantial buildings and a fair amount of stock.

During the season a rainfall of 2·18 inches during April created an excellent seed bed and the crops during May were in splendid condition and well advanced. With the prospects of the customary June rains the farmers unfortunately delayed irrigation work in spite of warnings given through the press and by the officials of the company at Strathmore. There was practically no useful rainfall during June. Hot dry winds during the middle and towards the end of the month caused great havoc to a very promising crop. The result should convince the farmers of the necessity for preparedness and of the desirability of a judicious application of water before the crops show signs of wilting. In this area soil moisture tests proved the urgent need for supplementing the soil moisture content and this was brought to the attention of the water-users by the company's officials and through the press, but, with few exceptions, without avail.

During the 1921 season 33,618 acres were irrigated, or 15·3 per cent of the total irrigable area.

Eastern Section.—During the year settlement in this area was somewhat retarded owing to the generally depressed world conditions. Many of the settlers already located have become more securely established during the year and have enlarged and improved their buildings.

The area actually under irrigation during the year was 88,299 acres as compared with 60,762 acres in 1920. Some 64,786 acres were seeded to wheat during 1921 and produced 850,842 bushels as against 37,260 acres producing 625,589 bushels in 1920.

The low yield during the year is attributed to very similar conditions, as to rainfall, temperatures, etc., as were experienced in the Western Section. The hot drying winds during the middle and towards the end of June proved exceedingly disastrous to the crops. These climatic conditions were not anticipated by the farmers, although they have been of frequent occurrence in the past. Irrigation was not applied in time to entirely save an otherwise very promising crop.

Owing chiefly to the decline in yield during recent dry years and to the drop in the price of wheat, many farmers have applied to the company to reduce their holdings. Under existing market conditions and the high price of labour they have realized they cannot operate large acreages of irrigated land. A system of more intensive cultivation with diversified crops and stock will undoubtedly eventually be followed.

The distribution system has been greatly enlarged during the year. This work was carried on throughout the operating season by means of nine "D.N.R." excavators and five drag lines of various types. In addition to this 379,000 cubic yards were excavated by teams. The mechanical excavators traversed 207 miles of ditches, enlarging, cleaning out and re-sloping banks.

The Antelope creek syphon was reconstructed and a ninety-inch creosoted wood-stave pipe, 1,740 feet in length was installed to replace three reinforced concrete barrel syphons which had become defective.

Repairs of an extensive nature have been completed in connection with the shell and pedestals of the Brooks aqueduct.

Lethbridge Section.—The total crop valuation for this district, during 1921, falls considerably below the figures of the preceding year, owing chiefly to the exceptional conditions during the critical months of May and June. With a rainfall of 1·42 inches during March, followed by 1·19 inches in April, a good seed bed was created and the land was in excellent condition. Crops, generally, were promising until the end of May, and in some cases even to the first week in June; so promising in fact, that very little attempt was made to irrigate. Many of the farmers, anticipating that the customary June rains would carry their crops through the month, did not prepare to irrigate. No rain of any appreciable value fell until the 16th and 17th of June, when 0·47 inch was recorded. On the 10th of the month very disastrous hot winds began to blow and lasted from three to four days, causing enormous damage to all crops in the district. These winds were again experienced between the 20th and 27th of the month. Although many farmers had decided to irrigate immediately after the first hot spell, the delay caused the crops to be badly burned before water could be turned on. It has, therefore, been again conclusively proved that it is fatal to wait until crops show signs of wilting before starting to irrigate. Furthermore, had these grain fields been fall irrigated, sufficient moisture would have been carried over in the soil to take care of the crop during the first heat wave and thus have given the farmers an opportunity of getting their ditches put in shape and the water applied to the fields. The lesson has been a costly one to many and in order that such a catastrophe should not overtake them in the future, a great many applied for fall irrigation, in fact, some 22,500 acres of grain land were irrigated during the fall of 1921, or nearly seventy per cent of the whole area likely to be seeded to grain in the spring of 1922. These lands will now have a reserve supply of moisture, sufficient to carry the crop along until water can be applied and this should render them immune from almost any drought conditions which may occur in 1922.

The average value of crops raised during 1920 on 79,650 acres was $49.31 per acre, whereas the results for 1921 show only $21.75 per acre over an area of 56,450 acres.

The chief reasons responsible for the great decrease in the per acre return as compared with the previous year, are: first, the general slump in prices of farm produce, and, second, the failure of the farmers to irrigate their grain at the proper time, the reasons for which have been outlined above. During the 1920 season, some 6·03 inches of rain fell during the months of April and May, as compared with 2·15 inches during the same months of 1921, which accounts for a great deal of the depreciation in crop yield. The wheat yield, for instance, rated only $11.68 per acre in 1921 as against $47.25 per acre in 1920.

A considerable amount of work has been done during the season on repairs and betterments, the Cameron lateral having been cleaned out and the banks raised. Re-grading and raising banks of other important laterals have also been undertaken at points where required.

TABER IRRIGATION DISTRICT

This district is now under operation and during 1921, 10,352 acres were irrigated, which represents sixty-one per cent of the total irrigable area. This was the first district to be erected under the Irrigation Districts Act of Alberta and its success has fully justified the expectations of its creators.

The farmers in this district are enthusiastic irrigators and the district diverted from Chin Coulee reservoir, during the season, about 34,998 acre-feet of water. Fall irrigation was generally practised and in this work the farmers were greatly assisted by an exceptionally open fall. Water was distributed throughout the district up to the end of October and a large acreage was irrigated.

In his annual report to the ratepayers, the secretary of this district has emphasized the value of fall irrigation and has recommended that the future operating policy should be to make regular deliveries of water up to the middle of October. The policy of running the system indiscriminately throughout the fall of the year is considered unsound. The heavy weed jams which occur in this district from time to time, often displace the smaller structures and necessitate the expenditure of a considerable amount of time and work to get them back into position. This work can usually be done to best advantage in October when the ditches are not in use.

The month of September, which should be devoted to fall irrigation where grain crops are grown, was, in fact, a month of low demand, only some 3,700 acre-feet being delivered, whereas during the month of October the quantity increased to some 9,300 acre-feet.

Water was turned into the system on May 17 and allowed to flow until the 27th for the purpose of priming and flushing the ditches. Water for irrigation purposes was turned into the system on the 4th June and the quantity was gradually increased until the 16th, when full capacity was carried. The system was operated at full capacity until July 27. During the extremely hot days in the latter part of July it has been reported that evaporation and seepage losses were particularly noticeable, the main canal falling from three to four inches during the afternoon, but increasing again at night. These losses take place in a length of some six miles of natural channel situated between the Chin reservoir and the headgates of the system. In this section the water spreads out over a large area in Chin coulee, varying in width from one quarter to one-half mile. It may be found advisable, as the district becomes more firmly established, to construct a canal on the east side of this coulee to avoid this waste of water.

THE SOUTH SASKATCHEWAN DIVERSION PROJECT

In the 1919-20 Annual Report a brief outline of the history of this project was given. In the 1920-21 report further reference was made to the project and some of its salient features were quoted from the report of the Saskatchewan Water Supply Commission issued early in 1921.

On July 27, 1921, a vote was taken of the municipal electors in the cities of Regina and Moose Jaw, and of the towns, villages and rural districts along the route of the proposed pipe line, who were to benefit by the scheme.

The voting resulted as follows:

	For	Against
Regina City	727	97
Moose Jaw City	1,184	286
Country districts including villages	748	1,449
	2,659	1,832

From this it is apparent that the cities of Regina and Moose Jaw were, by a large majority, in favour of the project, but the rural district vote was overwhelmingly against it. It was necessary for the ultimate economic success of the scheme that a large percentage of the vote should be in the affirmative, in fact, it required a majority in each of the voting units to warrant proceeding. The vote in the country unit failed to give such a warrant although the villages were in favour of the scheme, but with the exception of two municipalities, the vote in the country was very small and with small adverse majorities. Some twelve townships out of the total area voted in favour of the scheme.

Since the vote was taken a number of petitions and resolutions from the villages, towns and cities have been received and the Water Supply Commission has reported in favour of a suggestion that the two cities take the initiative and form a water district to which may be added, by petition, the villages or such of the country districts as may indicate their desire to do so, in accordance with conditions that would be satisfactory to all. This recommendation was forwarded by the cities to the Government, but on account of the present depressed financial outlook the matter is in abeyance. In spite of the unfavourable financial conditions existing at the moment, interest in the scheme has not waned and those in favour are keenly alive to the necessity of initiating the necessary proceedings along the lines which have been indicated by the Commission, as soon as times are propitious.

CANADA LAND AND IRRIGATION COMPANY

During the past year this company delivered 22,204 acre-feet of water to 9,400 acres of land, about ten per cent of which was fall irrigated. The water was turned into the system on May 12, and shut off on November 1, 1921. Approximately 92,000 acre-feet were delivered from Bow river into Lake McGregor reservoir. Some fifty-two water agreements have been filed and none have been cancelled. The total area at present covered by water agreements is 10,784·52 acres.

Some construction was undertaken during the season in connection with the operation and maintenance of the system. In addition some reconstruction was carried out along the main canal near East Arrowwood syphon, the main canal being re-aligned and carried in deeper cutting to avoid further damage from the dangerous sliding banks in this vicinity.

The Little Bow canal between lake McGregor and Little Bow reservoir has been re-aligned and enlarged, and the outer banks have been strengthened.

In the Vauxhall district a considerable number of drops, culverts, weirs, etc., were constructed and about 254 miles of laterals excavated. The available storage at the end of the irrigation season in lake McGregor reservoir was 100,000 acre-feet and 13,700 acre-feet in the Little Bow reservoir.

The gates of the Little Bow reservoir were opened on May 10, and water reached the Western district for irrigation purposes on May 20. The Little Bow gates were closed for the season on October 4.

Considerable agricultural development has taken place in the vicinity of Vauxhall during the year with marked success. Regulations governing the operation and maintenance of the project have been drawn up and duly confirmed as required under the provisions of the Irrigation Act.

LETHBRIDGE NORTHERN IRRIGATION DISTRICT

All survey and construction work in this district was carried on by the trustees of the district under the general supervision of the Provincial Irrigation Council. The Provincial Legislature during the session of 1921, passed an Act guaranteeing in full the principal and interest of the bonds of the district

amounting to $5,400,000, a sum estimated to be sufficient to cover the entire cost. The chief engineer in charge of construction is Mr. H. B. Muckleston, M.E.I.C.

During the field season of 1920 the district placed two parties in the field on location of the main and branch canals. In the spring of 1921, with a view to early commencement of construction, further additions to the engineering staff were made. The district was divided, for purposes of construction, into five residencies with an engineer in charge of each.

Tenders for earthwork were considered by the Irrigation Council on June 1, and the contract was awarded to Messrs. Grant, Smith & Co. and McDonnell, Ltd., the lowest bidders. This contract called for completion by May 1, 1923, the total being $1,660,279.40.

Messrs. Grant, Smith & Co. and McDonnell let the greater portion of work to subcontractors by whom it was for the most part again sublet to men with small outfits.

The work was commenced as soon after awarding the contract as organization by the contractor could be effected and was carried on vigorously during the summer and fall. Some trouble was experienced during harvest in finding suitable labour but work was not delayed on this account to any great extent.

Unfavourable winter weather developed early in November and consequently the greater portion of the contractor's force was withdrawn for the winter. During this month only drag lines on main canal at intake and inlet cut at Keho Lake reservoir remained at work. During December the drag line at the intake was withdrawn but the remaining excavator continued at work during the winter.

As was to be expected on a project covering such an area the material excavated varied considerably. The gravel encountered for some two miles north of the Oldman flume will undoubtedly cause large seepage losses and the canal may require lining. Solid rock in quantities considerably greater than anticipated, has been encountered in the inlet cut to Keho lake, but it is being excavated by drag line without serious difficulty—after blasting—and will not delay the completion of the project. In the outlet cut from the above lake a very hard gumbo formation exists which even after blasting, has caused considerable delay to the light type of drag line operating at this point. In the Turin district a considerable amount of sand, principally on small laterals, has been excavated.

With indications that an abundance of labour will be available it is not thought that any difficulty will be experienced in completing excavation during the season of 1922 in view of the fact that fifty-nine per cent of the contract was completed in 1921 when work was not fully under way until July.

During July tenders were opened by the Secretary of the Irrigation Council for a number of concrete and timber structures. Eight tenders were received, the lowest being that of Messrs A. G. Creelman & Co. to whom the contract was awarded for $134,719.95.

In September contract was awarded for masonry in headworks, syphon, spillway and crossing of Oldman river and timber trestle work at Oldman crossing; Messrs Creelman & Co. were again the successful tenderers, the total amount of the accepted tender being $364,619.50. Details of these tenders are on record in the office of the Reclamation Service.

Timber for small structures.—A contract for the supply of 2,992,194 F.B.M lumber and 15,132 linear feet piling was awarded during November to the Jewell Lumber Company, Limited, of Vancouver, B.C. The material will be used in small structures and contract called for delivery F.O.B. at three points, Macleod, Nobleford, and Commerce, at prices ranging from $30 to $38.90 per M. for timber and at twenty-nine cents per linear foot for piling.

Metal Flume.—Contract was awarded to Pacific Sheet Metal Works, Limited, of Vancouver for flumes erected complete in place on substructures provided at Oldman river and Willow creek. The flumes are to be semicircular with a circumference of 270 inches. The prices follow:

Oldman river 3,322 lin. ft. @ $11.25..	$37,372 50
Willow creek 588 lin. ft. @ $11.25..	6,615 00
Total..	$43,987 50

Wood-Stave Pipe Syphons.—The contract awarded to The Canadian Pipe Co. Ltd., of Vancouver, B.C., calls for the design, manufacture, shipment and erection complete in place on concrete pedestals supplied by the district of a 10 foot 6 inch internal diameter wood-stave pipe syphon also the manufacture, shipment and erection of cradles for the support of same. The prices are as follows:—

Rocky Coulee, 2855 linear feet at $32.15	$ 91,788 25
Kenex, 930 linear feet at $32.15	29,899 50
	$121,687 75

Steel Work, Oldman and Willow Creek Crossings.—A contract was awarded to the Dominion Bridge Company, Limited, of Canada for the steel structures for the Oldman and Willow creek crossings, the accepted tender being for $110,386.

UNITED IRRIGATION DISTRICT

This district as now organized, includes the former United and Lone Rock Irrigation Districts and contains the following acreage:—

District	Irrigable	Non-Irrigable
Former United District	14,947	26,334·4
Former Lone Rock District	8,177	8,726·5
Present United Irrigation District	23,124	35,060·9

Mr. D. W. Hays was employed as consulting engineer by the Provincial Government to report on the project and on the desirability of the guarantee of the bond issue.

Mr. Hays reported favourably under date April 9, 1921, this report being conditional on the guarantee of adequate water rights. The matter of water rights was satisfactorily adjusted so that the district can be granted the quantity necessary for its full development. The application of the district was therefore approved and authorization for the construction of the works issued on June 29, 1921, steps being at once taken by the district towards financing the scheme. The Board of Trustees prepared an estimate of the sum required to defray expenses in connection with the formation of the district and to construct the proposed works, amounting to $524,606. It was estimated that the annual charge for maintenance and operation would be $35,619 and that $113,019 would be required to defray interest charges etc., until the end of one year after the completion of the works. This estimate was approved by the Irrigation Council which authorized the trustees to raise a loan of $645,000 to cover the amounts required in connection with the formation of the district, construction and interest charges.

Main canal from station 2+80. This portion of canal is one bank only. Excavation made by drag line. Water in canal is seepage from Oldman river.

Elevating grader casting—Monarch Branch.

Drag line in inlet cut Keho lake, January 7, 1922.

Typical scraper outfit at work main canal station 2456.

Elevating grader with dump wagons—main canal west end inlet cut, Keho lake.

Commencement of excavation for pier No. 7, Oldman flume—January 4, 1922.

Lethbridge Northern Irrigation District, Willow creek flume—June 12, 1922.

Lethbridge Northern Irrigation District, Willow creek flume—June 12, 1922.

A by-law was prepared, submitted to the ratepayers of the district on August 24, and passed by a large majority. The district was authorized to borrow $60,000 to cover preliminary and construction costs pending guarantee of the bonds by the Provincial Government. The contract for supervision and engineering was awarded to Mr. D. W. Hays who had previously reported on the district.

For construction purposes the district adopted the system of letting small contracts to ratepayers in preference to awarding contracts in a lump sum. These contracts were awarded on the following basis:—

Sixty per cent to be paid on monthly estimate.

Fifteen per cent to be paid on satisfactory completion of contract.

Twenty-five per cent to be retained and held in trust to apply on assessments to be levied on the lands in respect of the charges due for bonds to be issued by the district.

Conditions in the district are particularly favourable for small contracts as no expensive machinery is required and a considerable number of ratepayers have had previous experience in the construction of irrigation works. Satisfactory results have been obtained to date and it is anticipated that this method will prove economical.

During October and November, twenty-one contracts were let, varying in size from about 5,000 to 25,000 cubic yards each. Excavation was commenced October 12 and continued until November 15, when operations had to be suspended owing to unsuitable weather conditions. During this period about seventy per cent of the eight miles of main canal opened was completed, the total yardage excavated being 166,743—almost entirely class III earth.

The expenditure of the district up to December 31, 1921, was as follows:—

Overhead	$ 3,857 75
Engineering and inspection	10,943 15
Structures	2,680 82
Excavation	25,235 59
General	724 83
Total	$43,442 14

The work of surveys and construction will be resumed in the spring of 1922 and an effort made to complete the system during the year.

The trustees of the district are Messrs S. B. Smith, Mountain View, Alberta, George Stringham and Edward Leavitt, Glenwoodville, Alberta, and the secretary is Mr. John Peterson, Cardston, Alberta.

SOUTH MACLEOD IRRIGATION DISTRICT

Application for the formation of the district was made to the Provincial Government June 18, 1921, as required under the provisions of the Alberta Irrigation Districts Act, 1920, and the district was officially organized by an Order dated September 21, 1921.

The irrigable area was originally estimated at 61,006·7 acres which included certain school and Crown lands. As special legislation is necessary for the taxing of such lands if included in an irrigation district, it has for the present been decided to exclude them and a reduction of 3,377·5 acres has been made on this account. A further reduction of 7,980·2 acres has also been made on account of withdrawals, revisions of classification, and alkali investigations, reducing the irrigable area to 49,649 acres.

The Minister of the Interior has approved the plans and a reservation of 85,190 acre-feet of water has been made from the Waterton river, the source of supply for the district.

The project has been reported upon by Mr. D. W. Hays, Consulting Engineer to the Provincial Government, who considers it entirely feasible. Some of the holdings are too large to be successfully operated as irrigation farms, and it is considered advisable to divide these holdings into smaller parcels; most of the large land holders have since withdrawn from the district, so this objection has been either eliminated or minimized in importance.

IRRIGATION DEVELOPMENT ASSOCIATION

This association, whose headquarters are located in the Board of Trade building at Lethbridge, is still actively interested in irrigation development. Any matters which directly affect irrigation interests or the further development of the country centering in Lethbridge, are usually taken up through the medium of the association. In this manner the association is doing useful work in furthering the interests of irrigation in the dry belt. During the past year the chairman (Mr. G. R. Marnoch), and the members of the association, appeared before the International Joint Commission at its hearing in Lethbridge in September, 1921, and presented the case of the farmers and business interests in connection with the division of the waters of the St. Mary and Milk rivers. The chairman also attended the hearings of the commission at Chinook, Montana.

The association has also taken an active interest in the Waterton lake storage, and in the general question of the development of storage reservoirs in Alberta.

READY MADE WATER USERS ASSOCIATION

This association operated successfully during the season and with the aid of a watermaster succeeded in distributing the water to its members to the satisfaction of all concerned.

PROPOSED ROBSART-VIDORA IRRIGATION DISTRICT

Reconnaissance surveys of this project were made during 1920 by Messrs. W. Wotherspoon and M. H. French. At that time it was proposed to utilize Cypress lake as a reservoir and the proposed district was then known officially as the "Cypress Lake irrigation district." As, however, it is now intended to abandon Cypress lake as a reservoir it is considered that a more appropriate name would be the "Robsart-Vidora irrigation district."

During the season of 1921 a party in charge of Mr. S. H. Hawkins, under the supervision of Mr. M. H. French, made a survey of the proposed district. An investigation of soil conditions was made by Mr. P. A. Fetterly, who had the benefit of the advice of Dr. F. T. Shutt (Dominion Chemist), who was at the time engaged on a tour of the various areas under irrigation development.

Mr. Hawkins reported that the lands in the proposed district are generally somewhat rough. The general slope is ample for drainage requirements, except in the sections bordering on Lonesome lake, where a small drainage channel may be required. Detailed surveys were made of proposed dam sites on the Frenchman river at the following locations:—

NE$\frac{1}{4}$ sec. 20, tp. 6, rge. 24, west 3rd meridian.
SE$\frac{1}{4}$ sec. 29, tp. 6, rge. 24, west 3rd meridian.

With a view to creating storage of 40,000 acre-feet on the Frenchman river, a detailed survey was made of the basin which would be flooded by the reservoir.

A canal system was projected from this reservoir to the irrigable lands and other necessary surveys were made. Detailed plans and cost estimates have since been completed. The following is a summarized estimate of cost of the proposed development:

FRENCHMAN RIVER RESERVOIR

Expropriation of deeded lands	$ 27,315 00
Main dam	78,081 50
Spillway on main dam	31,654 47
Outlet to Frenchman river	1,987 50
Sucker creek diversion	4,434 00
Road diversion	5,000 00
Dam and headgate at head of main canal	10,064 00
Total cost of reservoir including all above items	$158,536 47
Main canal headgate to and including division gates	61,688 50
East branch main canal and distributaries	39,060 75
West branch main canal and distributaries	53,297 75
Total cost	$312,583 47
Add 10 per cent for contingencies	31,258 35
	$343,841 82

Total gross capacity for Frenchman river reservoir is 64,500 acre-feet. Net capacity available at canal headgate sill level is 40,000 acre-feet. Superficial area of reservoir at five feet above spillway weir crest is 3,800 acres. It is considered that the water level will rarely if ever rise above this elevation (3,188·4) and estimates for land expropriation and damages include all properties below this contour.

The cost per acre-foot of the 40,000 acre-feet of available storage is:

$$\frac{\$158,536\ 47}{40,000} = \$3.96$$

The quantity of water stored per acre to be irrigated is 3·6 acre-feet. Cost of storage per acre irrigated for 11,125 acres is $14.24

Mr. French's report is very full and comprehensive. He considers that the available water supply is adequate. Climatic conditions are such that irrigation is desirable both as an insurance against drought and as a means of developing mixed farming. The cost is reasonable and the district is well settled. As regards soil conditions he has expressed the opinion that they are suitable, but a final report dealing with this is now in course of preparation. He further considers the low yield of wheat grown upon the summer-fallowed land during the past ten years as good evidence that irrigation is desirable. He states: "If crops grown under good average farming methods, as now practised, are not profitable, there must be a change in methods if the people are to continue farming in that district. The further depletion of the soil fertility and humus will but aggravate conditions. One method of overcoming the effects of continued drought is by irrigation, which will supply the required moisture and stabilize agriculture in that vicinity."

Mr. P. A. Fetterly in his report on the soil conditions states in part as follows:—

> "A total of 154 groups of soil samples was obtained in the district and tested by means of the electrolytic bridge for alkali content. Thirty-

three of the groups were obtained by Mr. French in 1920 and many of them were sent to Ottawa for analysis. Ninety groups were obtained by myself in 1921 and tested. Thirty-two were obtained by Dr. Shutt and myself in September, 1921, and many of these also were sent to Ottawa for analysis.

"It is a remarkable fact that no alkali salts appear on the surface throughout the whole proposed project under natural conditions, except at two points, one under a cut bank in the immediate vicinity of Battle creek, and the other in a coulee in the southwest of section 19, township 4, range 25; nor were there the usual signs in genus and quantity of vegetation which usually characterize lands where alkali comes to within a foot or less of the surface. This condition is unique. Occasionally small areas were found where the vegetation was evidently slightly affected, but these areas were of small extent compared with the total area where alkali extended to a point near the surface. This as a general rule may be taken as a favourable sign."

It is difficult to form any definite conclusions as to the suitability of the soil throughout the entire area owing to uncertainty as to the nature of the salts present and to their movement after irrigation under all conditions. It will only be possible to give an authoritative opinion after the soils have been analysed physically and chemically.

In regard to the surface drainage requirements, Mr. Fetterly states as follows:—

" It will be necessary to provide surface drainage for the different parts of this tract and it is suggested that this be carried out and charged to the district as a whole in the same manner as in the case of an irrigation ditch, as some parcels are more favourably situated than others as to drainage facilities, and all should be treated on a basis of equal distribution of cost.

"Taking the scheme as a whole it is considered that the seepage question will enter into the matter very materially. It is probable that some lands immediately under all contour ditches may be affected to some extent by rise of alkali because of seepage water passing through alkali-impregnated subsoil, and then appearing on and near the surface below the ditch. Consequently contour ditches should be as few as possible.

"The seepage question appears serious because the ditches occasionally pass through lands with alkali in the subsoil. It is believed, at present at least, that the application of water will tend to drive the alkali downward except where it may come in contact with an impervious layer. At such places it will flow along the top of this layer, carrying the dissolved alkali along with it to the surface of the ground. This, however, is an ever-present possibility in most semi-arid lands under irrigation.

"It will be advisable to apply water sparingly to the soil as more than a moderate duty of water might easily prove injurious because of the presence of alkali."

LITTLE BOW IRRIGATION DISTRICT

The necessary notice of application to form " The Little Bow irrigation district," was issued by the Minister of Public Works for the province on January 11, 1922, and published in the *Alberta Gazette* of January 14, 1922.

The necessary Ministerial Order for the formation of the district was made and promulgated on March 5, 1922, and published in the *Alberta Gazette* of March 15, 1922. The following gentlemen were declared to be appointed as

the first trustees:—Messrs. Charles W. Folk, D. O. McKay, Ernest L. Nowlin, all of Carmangay. The secretary of the district is Mr. H. S. Parker also of Carmangay.

Originally there were thirty-one petitioners desiring to construct works to divert water from the Little Bow river for irrigation purposes. Of this number thirty desired to obtain water by pumping and one by direct gravity diversion from a dam. Since the estimates of cost of each individual scheme were submitted, two petitioners have withdrawn owing to excessive cost. On account of the fact that several of the applicants have two or more points of diversion the total number of schemes surveyed and estimated on, amounted to forty-six. The necessary surveys and plans were made by Mr. John Haddin, M.E.I.C., of Calgary, who has charge of the engineering work for the district.

As outlined in last year's report, it is proposed to divert water from the Highwood river into the Little Bow river at the town of High River. The necessary surveys and estimates for the construction of these diversion works were made during the season of 1921. A comprehensive report outlining the proposed diversion works, together with plans and estimate of cost, was submitted to the district by their engineer in June, 1921. In this report the cost of the headworks on the Highwood river and the necessary canal, structures, and right of way to connect with the Little Bow river was estimated at $32,930. As the Government of the province has consented to assume half of this cost the capital cost per irrigable acre was at the time estimated at $5.85 and the annual charges per acre for maintenance and operation at fifty-nine cents. Some slight changes are, however, now being made in the irrigable areas and two or three of the small schemes may be eliminated, which may slightly increase the per acre cost.

The project varies considerably from the usual irrigation district scheme in that in this case each individual farmer will construct his own works and purchase the necessary pumping equipment. The district as a whole will sell the necessary bonds for the construction of the headworks at High River and the Government of the province of Alberta will reimburse the district following completion and construction of satisfactory works having sufficient capacity to divert, in addition to the district's own requirements, the fifty cubic feet per second for domestic purposes covered by license now held by the province. It is understood the arrangement is that half the bond issue will be purchased by the Government from the district, or bonds up to an amount not exceeding $18,000.

The total irrigable area has been estimated at 3,350 acres, but this area may be slightly increased as several other riparian owners have recently expressed a wish to be included in the district.

Authorization to construct works under the provisions of the Irrigation Act will be issued as soon as the necessary advertising has been completed. Construction should be completed during the present year if no unforeseen difficulties are encountered.

SURVEYS

NORTH SASKATCHEWAN PROJECT

A general description of this project may be found in the annual report for 1919-20. Provision was made in the estimates for the year 1921 for a detailed investigation of this project and the following parties were employed under the general supervision of Mr. B. Russell, A.M.E.I.C., as chief field inspector. One 16-man location party (No. 13) in charge of Mr. I. R. Strome, A.M.E.I.C.; one 6-man reconnaissance party (No. 14) in charge of Mr. A. B. Cook; two 13-man levelling parties (Nos. 15 and 16) in charge respectively of Messrs. H. M. Barton and T. C. Dennis. Mr. R. V. Heathcott later took over party No. 16, when Mr. Dennis returned to Ottawa.

Party No. 13 was employed to make the surveys for main canals from the North Saskatchewan, Clearwater and Red Deer rivers to the proposed Buffalo Lake reservoir. These surveys showed that it is quite feasible to make these diversions and that there are several possible routes from the Red Deer river. The actual number of working days completed by this party was 131½. During the season the party ran 237·5 miles of traverse with profile and topography, 22 miles of reconnaissance levels, 162·5 miles of check levels and also established twelve permanent bench-marks and made one hundred ties with the land survey lines.

Party No. 14 was employed to make a reconnaissance of Buffalo lake and the surrounding country with a view to locating a feasible route for a canal from Buffalo lake to the irrigable lands. In addition to this, a reconnaissance was made, without instruments, of approximately 500 miles over various possible canal routes.

The levelling parties, Nos. 15 and 16, were employed to run levels along township lines throughout the possible irrigable block of land commanded and to gain all possible data in regard to its topography and general suitability for irrigation. During the season these parties ran 4,118·5 miles of levels established 244 permanent bench-marks and inspected and sketched the topography in 287 townships. The average rate per level per day was about 5·4 miles.

From the information gained in the field, tentative studies have been made of the available water supply, probable irrigable areas, required canal capacities and general distribution system.

Two alternative schemes have been studied to some extent, one anticipating the use of Buffalo lake as a storage reservoir and the other Sullivan lake.

Sullivan lake is a more economical reservoir site than Buffalo lake as a larger area of land can be commanded from it; and the proposed Sullivan lake route to the irrigable land is more direct than the Buffalo lake route. There are a number of other advantages which the Sullivan lake route has over the Buffalo lake route, and it is proposed to thoroughly investigate it during the next field season. Tentative estimates compiled show the following:—

	Commanded Area.	Irrigable Area.
Under Buffalo lake route..	3,003,760 acs.	1,564,784 acs.
Under Sullivan lake route..	3,538,760 acs.	1,778,784 acs.

The estimated capacity of the proposed canal from the Red Deer river to the storage reservoir (Buffalo lake or Sullivan lake) is about 10,300 c.f.s. and the estimated capacity of the proposed canal from this reservoir to the irrigable lands is about 22,600 c.f.s.

With storage on the North Saskatchewan river of approximately 239,000 acre-feet (estimated capacity of reservoir investigated by the Water Power Branch) and a further storage capacity of approximately 1,000,000 acre-feet at either Buffalo or Sullivan lake, it is estimated that there is sufficient water available from the North Saskatchewan, Clearwater and Red Deer rivers to provide adequately for all irrigable land under either of the proposed schemes.

During the coming season five parties will be put in the field to gain sufficient further information to permit of preliminary estimate being prepared. These parties will be made up as follows: two reconnaissance parties of thirteen men each, two levelling parties of thirteen men each and one reservoir-site party of three men.

LETHBRIDGE SOUTHEAST PROJECT

The first surveys of this project by the Dominion Government were commenced in 1912, primarily for the purpose of gaining certain information for the International Joint Commission. These surveys were continued throughout 1914

and reports dealing with irrigation possibilities were published. Plane-table surveys of all lands in this project were made during 1919, 1920 and 1921 and one location party was employed during 1919 and 1920 to survey a number of canal routes from the various sources of supply to the tracts of irrigable land.

Field Work, 1921.—In addition to a five-plane-table party which was employed to complete the plane-table surveys a small party was employed during a part of the season to make a classification of all lands in the Alberta Railway and Irrigation Company's tract. These lands had never been properly classified and this work was necessary in order to make proper provision for canal capacity and water supply. The canal system of the Alberta Railway and Irrigation Company must of necessity form an important link of the Lethbridge Southeast project and a study of the system was necessary in the design and estimate of that project.

This plane-table party was in charge of Mr. L. A. McGillivray. The actual number of plane-table-days spent on the work was 414, and the total area plane-tabled 127,744 acres, making an average of 308·5 acres per plane-table per day, which is a high average for this class of work. The average cost for the whole area (774,597 acres) was 18·5 cents per acre, which, considering the high prices during these years, is very reasonable.

The small party in charge of Mr. S. H. Hawkins classified all lands that could be irrigated by the Alberta Railway and Irrigation Company and from this classification the following estimate has been made:—

ALBERTA RAILWAY AND IRRIGATION COMPANY SYSTEM

Tract	Maximum irrigable acres	Irrigable acres covered by water agreements	Additional area which can be irrigated
	acres	acres	acres
Magrath	5,000	1,902	3,098
Raymond	32,318	9,527	22,791
Lethbridge	96,399	68,242	28,157
Coaldale			
Total	133,717	79,671	54,046

The total cost of classifying 133,717 acres was $1,148.30 or at the rate of 0·86 of one cent per irrigable acre.

With the exception of some less important work, all surveys of this project have been completed and the accompanying cost estimates are based on these surveys.

General Description.—A full description of this project was published as a result of preliminary surveys made in 1913 and 1914. It will be seen from the accompanying general plan (plan No. 1) that the result of the plane-table surveys has not been to change the general layout to a great extent, but to more accurately define the irrigable areas in the various tracts and facilitate the projection of an economical distributary system.

The total area estimated as irrigable from the surveys made in 1913 and 1914 was 510,756 acres and the area found irrigable as a result of the plane-table surveys was 487,379 acres in the Alberta Railway and Irrigation Company's tract, Lethbridge Southeast tracts and Taber district, a difference of 23,371 acres. The ratio of irrigable area to commanded area estimated from the surveys made in 1913 and 1914 was as 42 to 100. The ratio of irrigable area to

the total area plane-tabled is as 43·5 to 100. These comparisons show that the earlier preliminary estimates were fairly close.

The ultimate development of this project takes into consideration all suitable lands in the large tract of country bounded on the west by St. Mary river, on the north by Belly river, on the east by Forty Mile coulee and Pakowki lake, and on the south by Milk river.

The total irrigable area in this tract, in addition to that already irrigated (Alberta Railway and Irrigation Company and Taber district), is 390,708 acres. An area of 54,046 acres can be irrigated by extending the present canals of the Alberta Railway and Irrigation Company. The remainder, 336,662 acres, can be irrigated by greatly enlarging and extending that system.

The topography and character of the soil throughout this area varies greatly. Although there are local ridges, coulees and depressions the general slope is toward the northeast. The topographical features which present the most serious obstacles are the three wide and deep coulees which, heading towards the western limit, traverse the area in a southeasterly direction.

Verdigris coulee heads near New Dayton and runs through to Milk river in sec. 11, tp. 2, rge. 14, W. 4th meridian. A height of land separates Tyrrel and Verdigris lakes, which lie in this coulee and form admirable sites in which to store water. The project anticipates the development of the Verdigris lake site to a capacity of 140,566 acre-feet. The development of Tyrrel lake is not necessary.

Etzikom coulee is the continuation of Kipp coulee which heads in the Milk river ridge, in tp. 4, rge. 21, W. 4th meridian. This coulee opens out into a large flat near the town of Stirling, where Stirling lake drains into it. Towards tp. 6, rge. 18, W. 4th meridian Etzikom coulee becomes deeper and from there to Pakowki lake is very wide and deep, resembling Verdigris coulee. This coulee and the depression through Stirling lake (in township 7) to Nine Mile coulee isolates a large area of country between Etzikom and Chin coulees in townships 6 and 7, ranges 16 to 20 inclusive, known as the Rolling hills, which as will be seen from plan No. 1, cannot be irrigated. Crow Indian lake, which is situated in this coulee in tp. 5, rge. 13, could be made to hold a large volume of water but is not a possible reservoir in connection with this project. Etzikom coulee terminates in Pakowki lake, which has no outlet and is twenty-three feet lower than Milk river at its nearest point. It is not feasible to drain this lake either to Milk river or to Chin coulee.

Chin coulee is a very wide and deep coulee which heads at a height of land in sec. 36, tp. 7, rge. 17, W. 4th meridian and runs both ways, viz. to the Belly river in sec. 17, tp. 10, rge. 17, W. 4th meridian, and to Forty Mile coulee near the lower end of Long lake in tp. 7, rge. 9, W. 4th meridian. In this coulee it is proposed to store 102,000 acre-feet of water. The Alberta Railway and Irrigation Company now has two reservoirs in this coulee, the Upper and Lower Chin sites, in which is now stored 42,920 acre-feet of water for use of the Taber district. A full development of the Lethbridge Southeast project contemplates increasing the upper site by 59,080 acre-feet.

These three coulees and other topographical features naturally divide the area into distinct tracts and for convenience the whole area has been divided into twenty-eight tracts, all of which are shown on plan No. 1. With the exception of the Foremost and Pakowki tracts the irrigable area is fairly compact. These two tracts require long and expensive supply canals, making the cost of irrigation per acre very high.

Soil Survey.—The soil conditions of the lands in this project were investigated by Mr. P. A. Fetterly and the quotations hereunder are from his report submitted on January 21, 1922.

Four hundred and forty-four soil groups were analysed. From the tests made by the electrolytic bridge the following results were obtained:—

	Groups
Alkali absent to a depth of at least five feet.	241
" above the three-foot depth.	114
" " one and one-half foot depth. .	62
" " five-tenths foot depth.	16
" present at all depths to five feet.	11
Total.	444

"These results indicate generally favourable conditions as far as alkali is concerned." Upon being further analysed by Dr. Shutt, Dominion Chemist, these groups were divided as follows:—

	Groups
Indicating suitable soil conditions for irrigation.	423
" unsuitable " "	21

"The fact that only five per cent of the total number of groups actually fall below the prescribed limits does not necessarily mean that no danger is to be anticipated from rise of alkali; it does mean that under proper and careful irrigation and cultivation little or no danger need be anticipated."

Mr. Fetterly gives a general description of soil conditions of the whole project and designates the parcels which should be eliminated on account of alkali. The total number of acres classified as otherwise irrigable but which had to be omitted on account of alkali is comparatively small.

Main Canal.—The principal changes from the earlier plans are in the main canals, particularly those from the Waterton and Belly rivers. Since these features are of great importance they will be discussed at some length.

In the first conception of this project the main canal of the Alberta Railway and Irrigation Company was considered the key to the whole situation, because it was known that the intake at Kimball was the only point on the St. Mary river where water could be diverted at a reasonable cost. In considering the diversion of the Waterton and Belly rivers the object was to bring these waters in above the intake of the Alberta Railway and Irrigation Company, from whence it could be carried to the east through an enlargement of that canal. The surveys made for a canal between the Belly and St. Mary rivers in 1912 and those made for the diversion of the Waterton and Belly rivers in 1914 were carried out with this in view. Either of these routes is possible. The Belly river diversion surveyed in 1912 is feasible and for the diversion of that stream alone would be the best route. For the full development of the Lethbridge Southeast project, however, Waterton river is required as well as Belly river. The surveys made in 1914 provide for the carrying over to a point above the intake of the main canal of the Alberta Railway and Irrigation Company, both Waterton and Belly river water. This is a very long route and that portion between Belly and St. Mary rivers is very expensive.

The high estimated cost of this canal, together with the difficulties of enlarging the main canal of the Alberta Railway and Irrigation Company to sufficient capacity to carry the waters of all three streams led to the present proposed scheme of dropping down Bullshorn coulee and carrying a canal across St. Mary river just west of Spring coulee, joining the main canal of the Alberta Railway and Irrigation Company at the Spring coulee headgates. This is the cheapest route from Waterton and Belly rivers. In regard to the Waterton,

Belly and St. Mary river diversions, three schemes were investigated to divert water to the Milk river reservoir.

First.—Storage capacity at Waterton lakes, 150,000 acre-feet; main canal from Waterton and Belly rivers via Bullshorn coulee and syphon crossing of St. Mary river in sec. 34, tp. 4, rge. 24, W. 4th meridian, joining the main canal of the Alberta Railway and Irrigation Company at the Spring coulee headgate; a high diversion dam in sec. 4, tp. 1, rge. 25, W. 4th meridian on St. Mary river and large storage canal through Mary lakes, Taylorville and Lumpy Butte reservoirs, delivering into the main canal of the Alberta Railway and Irrigation Company (Pinepound coulee) in sec. 19, tp. 3, rge. 23, W. 4th meridian.

Second.—Similar to the first with respect to the Waterton and Belly river diversions but leaving out the high diversion dam on St. Mary river in sec. 4, tp. 1, rge. 25, and the consequent canals and reservoirs, and diverting all the water from St. Mary river by a suitable enlargement of the main canal of the Alberta Railway and Irrigation Company.

Third.—Similar to the first and second with respect to the Waterton and Belly river diversions as far as Bullshorn coulee, but from this point instead of carrying the water to the proposed syphon crossing of St. Mary river, carrying it straight to St. Mary river and then by means of a high dam on St. Mary river at the proposed syphon crossing, sec. 34, tp. 4, rge. 24, W. 4th meridian, diverting Waterton, Belly, and St. Mary rivers water and carrying it to the Spring coulee headgates as in the second scheme.

From comparative estimates made the costs of these three schemes were found to be as follows:—

First scheme..	$7,170,300.00
Second scheme..	5,082,250.00
Third scheme..	6,067,920.00

Some of the items in the first and third were only roughly estimated, but for comparative purposes are sufficiently close. In both these plans high and expensive dams are required on St. Mary river. In the former water would be backed up into the United States, flooding approximately 110 acres of their territory, thus introducing an international question. In the latter the St. Mary river dam would cause flooding of the valley for a length of fifteen miles and would necessitate the re-location and construction of a portion of the Cardston Branch of the Canadian Pacific Railway.

The second was chosen and the accompanying cost estimates have been based on diverting the waters in the manner indicated therein.

Waterton River Diversion.—The point of diversion on Waterton river is near the north boundary of sec. 30, tp. 3, rge. 28, W. 4th meridian. It is proposed to divert the water here by means of a weir 420 feet in length with a maximum height of thirteen feet. The weir was designed for gravel foundation and of sufficient capacity to pass a flood of 30,000 second-feet. No tests have yet been made to determine the character of the foundations.

The canal from Waterton to Belly river has been designed to carry 1,100 second-feet. The first four miles will be on very steep side hill and require heavy earthwork. Several short flumes will be necessary to carry the canal across coulees. There is no heavy work throughout the remainder of the route. The water is dropped into Belly river by means of a chute in the SW. $\frac{1}{4}$, sec. 13, tp. 3, rge. 28, W. 4th meridian just above the proposed intake on that stream. The total drop disposed of in this way is forty-four feet.

Belly River Diversion.—Waterton and Belly rivers' water will be diverted from Belly river in the NE. $\frac{1}{4}$, sec. 13, tp. 3, rge. 28, W. 4th meridian, by means

of a weir 400 feet in length with a maximum height of eleven feet. This weir was designed for gravel foundation and of sufficient capacity to pass a flood of 20,000 second-feet. The site for the proposed diversion works is a good one in that there is little danger of the river ever changing its course. The headgates will be in solid rock and it is possible that when tests are made of the foundation that the weir will rest on solid rock as well.

The canal from Belly river to the Spring coulee headgates in the NE. $\frac{1}{4}$, sec. 17, tp. 4, rge. 23, W. 4th meridian, has been designed to carry 1,700 second-feet. The first 3,000 feet of this canal will be along fairly steep side hill close to Belly river and some protection from the river may eventually be required. Immediately after leaving the river this canal will be carried across the mouth of Mami creek by a flume 367 feet in length and of maximum height to full supply level of twenty-three feet. From Mami creek for a distance of about two miles the canal will be on side hill, some of which is fairly steep, but no construction difficulties are anticipated.

The controlling elevation is a summit on the Blood Indian Reserve in what would be sec. 36, tp. 3, rge. 27, W. 4th meridian. The elevation here is 3,906 feet, and the estimated full supply level of the canal is 3,890, making the maximum depth of cut required above full supply level sixteen feet. The total length of this summit cut will be 4,000 feet. From the summit the water will be dropped freely down Bullshorn coulee to a point in what would be sec. 7, tp. 4, rge. 25, W. 4th meridian, where it is proposed to re-divert it by means of an earth dam 2,200 feet long with a maximum height of forty-eight feet.

The full supply elevation of the canal at this point is approximately 3,602 feet, making a total drop of 288 feet to be taken up in the channel of Bullshorn coulee. It is possible that some protection may eventually be required to this channel, but this has not been provided for in the initial estimates of the project.

From Bullshorn coulee to St. Mary river there will be no difficulty, the only structures being two flumes, one just east of the Bullshorn coulee headworks and the other at Whitecalf coulee at a distance of about eight miles below the headgate.

It is proposed to cross the St. Mary river valley in the NE. $\frac{1}{4}$, sec. 34, tp. 4, rge. 24, W. 4th meridian, by a double barrel syphon consisting of two 11-foot diameter continuous wood-stave pipes, carried across the river by two through truss spans each 125 feet in length. The total length of the syphon will be 1,720 feet and the maximum pressure head 133 feet.

The controlling elevation of the portion of the canal between St. Mary river and the Spring coulee headgates is the summit in the centre of sec. 26, tp. 4, rge. 24, W. 4th meridian, which is 3,609·5 feet. The full supply level of the proposed canal here is approximately 3,583 feet, making the maximum depth of cut required above full supply level twenty-six and one-half feet. The total length of this cut will be 5,300 feet.

With the exception of the St. Mary river crossing and the above summit cut there will be no difficulty in constructing the canal from Bullshorn coulee to the Spring coulee headgates, where the water is turned into the main canal of the Alberta Railway and Irrigation Company.

St. Mary River Diversion.—The three schemes investigated for diverting the St. Mary river have already been outlined. The point of diversion chosen is that of the present main canal of the Alberta Railway and Irrigation Company at Kimball. The two other sites investigated were at the following locations:

First.—Sec. 4, tp. 1, rge. 25, W. 4th meridian.
Second.—Sec. 34, tp. 4, rge. 24, W. 4th meridian.

At the first of the above locations a dam 125 feet high with a crest length of 630 feet would be required. The site is a good one for the construction of

a high dam, consisting of a solid sandstone section. Test borings made here proved the foundation to be suitable for the construction of a dam of any type. Tentative estimates have been made for a rock-fill dam.

By means of this dam, water could be diverted to the Mary lakes and thence through the proposed Taylorville reservoir, Rolph creek and the proposed Lumpy Butte reservoir back to the main canal of the Alberta Railway and Irrigation Company in Pinepound coulee sec. 19, tp. 3, rge. 23, W. 4th meridian. The storage gained by such a diversion would be as follows:

St. Mary river reservoir..	27,000	acre-feet.
Mary lake reservoir..	26,000	"
Taylorville reservoir..	7,442	"
Lumpy Butte reservoir..	11,981	"
Total..	72,423	"

In view of the fact that this storage would only be required in very dry years it is considered that the cost of making this diversion is not warranted.

At the second of the above locations a dam 185 feet in height with a crest length of 1,800 feet would be required. No test borings were made at this site but the foundations are doubtful, consisting of what appears to be a poor quality of sandstone. This diversion would do away with the main canal of the Alberta Railway and Irrigation Company as far as the Spring coulee headgates and have the advantage of gaining the flow of Lee creek. It is not considered that the advantages of such a diversion would warrant the additional cost.

The canal from Kimball to the Spring coulee headgates has been designed to carry 1,600 second-feet and the cost estimates are based on enlarging the main canal of the Alberta Railway and Irrigation Company to that capacity. Provision has been made to partly control the flow down Pinepound coulee and to enlarge all structures including the Kimball headgates.

Milk River Feeder Canal.—The water from Waterton, Belly, and St. Mary rivers is diverted at a point on West Pothole coulee in sec. 6, tp. 5, rge. 22, W. 4th meridian, by division gates, from whence it is proposed to construct a canal of 2,200 second-feet capacity to the Milk river reservoir. The main canal of the Alberta Railway and Irrigation Company has been designed to carry 1,200 second-feet as far as the Magrath lateral headgate and 1,000 second-feet from there to the Nine Mile coulee headgate.

With the exception of several flumes and a syphon crossing of Pothole coulee the canal to Milk river reservoir presents no serious obstacles. The first flume is at a distance of 4,000 feet from the division gate and is 600 feet long at a maximum height to full supply level of sixty-one feet. Pothole coulee is crossed in sec. 34, tp. 4, rge. 22, W. 4th meridian, by a double barrel syphon consisting of two continuous wood-stave pipes each twelve and four-tenths feet in diameter supported on cradles. The length of this proposed syphon is estimated at 3,000 feet and the maximum pressure head is approximately ninety-seven feet. A flume 400 feet long at a maximum height of thirty-five feet is required to cross a small coulee just below the Pothole coulee crossing, and another flume 330 feet long at a maximum height of seventeen feet is required at mile eleven from the intake. A drop of approximately seventeen feet is required at the Milk River reservoir, the full supply level of which is 3,355 feet.

Milk River and Raymond Reservoir and Supply Canals.—From the Milk River reservoir the canal system is more complicated. It is proposed to develop this site to a capacity of 80,723 acre-feet by the construction of two earth dams, one at the north side and the other at the east end. A small earth dyke is

also required at the west end. From this proposed reservoir provision has been made to divert water at the east end through Middle coulee to the Middle coulee tract and the proposed Verdigris reservoir, and at the north side to the South New Dayton tract and the proposed Raymond reservoir.

It is proposed to develop the Raymond reservoir to a capacity of 16,933 acre-feet by the construction of two earth dams, one at the east end and the other at the north side. Provision has been made to divert water either to the North New Dayton tract or back to the main canal of the Alberta Railway and Irrigation Company in Nine Mile coulee. This latter canal is termed a balancing canal because by means of it the amount of water delivered from the Milk river and Raymond reservoirs is properly balanced between lands to the east and lands to the north of these reservoirs. The lands irrigable from this proposed canal have been termed the Balancing Canal tract.

Middle Coulee Branch.—This canal takes out of the east end of the proposed Milk River reservoir by means of a heavy cut through the summit between this site and the head of Middle coulee. It is proposed to carry the water freely down the channel of Middle coulee, thence through a constructed canal to division gates in sec. 35, tp. 4, rge. 17, W. 4th meridian, from whence it is either diverted directly to lands in the Middle coulee tract or to the proposed Verdigris reservoir and thence either to Milk river or to tracts to the east and north. The total drop disposed of in this natural channel of Middle coulee is 125 feet. From the division gates in sec. 35, tp. 4, rge. 17, W. 4th meridian, the distributary canal is carried across the north end of Western lake by a flume 1,984 feet long at a maximum height of 28 feet. This canal has been designed to carry 212 second-feet, the requirements of the Middle coulee tract.

Milk River Diversion.—It is proposed to divert Milk river at a point in sec. 30, tp. 2, rge. 17, W. 4th meridian. This is the point at which the Alberta Railway and Irrigation Company constructed diversion works some years ago for the purpose of carrying water to the proposed Milk River reservoir. A portion of a canal (some twelve miles) also constructed by that company can be repaired and used to carry water to the Milk River and Warner tracts.

The amount of flow in Milk river to which Canada is entitled under the International Waterways Treaty is insufficient for the requirements of these tracts, but provision has been made to irrigate them from water turned into Milk river by the United States, an equal amount to be returned to the river through Verdigris coulee. This scheme contemplates a joint arrangement between the United States and Canada for the exchange of controlled water.

The Milk River canal has been designed to carry 385 second-feet, the requirements of the Milk River and Warner tracts. Flood waters will be run to Verdigris reservoir through a natural channel.

A tentative cost estimate to repair the "Old Milk River canal" has been compiled from a report made by the late Mr. R. J. Burley, M.E.I.C., November 5, 1915. A further field investigation and cost estimate will be made during the field season of 1922.

Supply Canals from Verdigris Reservoir.—In addition to compensating the United States for their water used on the Milk River and Warner tracts (total irrigable area 36,698 acres) the Verdigris reservoir will supply the following:—

East Verdigris tract.	11,112	acres.
Pakowki tract.	28,223	"
Foremost tract.	20,284	"

The total area under the Verdigris reservoir is thus 96,317 acres.

The canal from the Verdigris reservoir to a proposed sluiceway in sec. 16, tp. 3, rge. 15, W. 4th meridian, about one mile below the reservoir, has been designed to carry 1,140 second-feet. At this gate provision has been made to divert 400 second-feet back to the coulee and 740 second-feet to the East Verdigris, Pakowki and Foremost tracts. At a gate in sec. 29, tp. 3, rge. 14, W. 4th meridian the water will again be divided. The canal to the Foremost tract has been designed to carry 285 second-feet and the canal to the Pakowki tract for 426 second-feet.

Main Canal to Foremost Tract.—The expensive features along this canal will be: a double fill some 3,100 feet long; a drop line to the proposed crossing of Chin coulee; a crossing of Chin coulee by means of a six-foot wood-stave syphon 6,300 feet long; a flume 800 feet long at a maximum height of nine feet and a single 68-inch wood-stave syphon 2,360 feet long.

Main Canal to Pakowki tract.—The expensive features along this canal will be,—three miles of side hill cut below Verdigris reservoir a 90-inch wood-stave syphon 1,905 feet long; a flume 960 feet long at a maximum height of 39 feet; a flume 624 feet long at a maximum height of 50 feet and a flume 688 feet long at a maximum height of 23 feet.

Proposed Enlargement of Alberta Railway and Irrigation Company's Canal from Nine Mile Coulee Headgate to Chin Reservoir.—Cost estimates have been based on enlarging the above canal to 2,200 second-feet capacity. This was designed to carry flood water through to Chin reservoir. By a more economical distribution, by which the bulk of the flood water will be carried to the Verdigris reservoir, it will be possible to reduce the capacity of this canal from the Lethbridge headgate in sec. 7, tp. 8, rge. 20, W. 4th meridian, to Chin reservoir to 1,250 second-feet capacity. Provision has been made to control the water through Nine Mile coulee and to enlarge all structures throughout. The total drop in Nine Mile coulee provided for by structures is 130·6 feet.

Supply Canal from Chin Reservoir.—This will be an enlargement of the canal now supplying the Taber district, which takes out of Chin coulee in sec. 36, tp. 9, rge. 19, W. 4th meridian, by means of a low dam. This canal has been designed to carry 973 second-feet or sufficient for the requirements of the following tracts:—

Taber district	17,000	acres
Proposed Taber West tract	7,342	"
" Horsefly Lake tract	8,586	"
" Big Bend tract	12,424	"
" Belly River tract	2,012	"
" Purple Springs tract	8,414	"
" Grassy Lake South tract	3,024	"
" " " North "	4,416	"
" Yellow Lake tract	16,713	"
" South Burdett tract	1,881	"
" North " "	6,691	"
Total	88,503	"

With the exception of a flume in sec. 21, tp. 9, rge. 17, W. 4th meridian, and a syphon in sec. 2, tp. 10, rge. 13, W. 4th meridian, there are no features requiring comment along the canals to the above tracts.

The canal to the Taber district now crosses a coulee in sec. 21, tp. 9, rge. 17, W. 4th meridian, by a flume constructed to carry 159 second-feet. It will be necessary to enlarge this flume to 433 second-feet capacity.

The syphon required at the above location will consist of a single four and one-half feet diameter continuous wood-stave pipe, 1,960 feet long under a maximum pressure head of eighty-two feet.

Main Canal to the East Chin and Forty Mile Coulee Tracts.—This canal has been designed to carry 1,065 second-feet, or sufficient for the requirements of 89,984 acres, the total irrigable area in the above tracts. It takes out of the proposed feeder canal to the Chin reservoir in sec. 27, tp. 8, rge. 18, W. 4th meridian. Water is dropped down 73·3 feet to this point from the Chin canal in sec. 16, tp. 8, rge. 18, W. 4th meridian, and then carried over Chin coulee by a syphon in sec. 27, tp. 8, rge. 18, W. 4th meridian.

It is proposed to cross this coulee by a syphon consisting of a single continuous wood-stave pipe ten and five-tenths feet in diameter 4,275 feet long under a maximum pressure head of 127·5 feet. The pipe will be carried across the canal between the Upper and Lower Chin reservoirs by an eighty-foot deck plate girder span supported on concrete and pile abutments.

With the exception of a drop line on the North Forty Mile coulee branch just below the proposed division gates in sec. 20, tp. 8, rge. 14, W. 4th meridian, there are no features on the canals serving the East Chin and Forty Mile coulee tracts which require comment. The total drop at the above location is eighty-five feet, fifty-five feet of which is taken up artificially; the remainder will be disposed of in natural channel.

Cost Estimates.—The total development of this project is recommended and the cost estimates submitted anticipate that this will be carried out. The possibility of developing a smaller area is however realized.

The doubt concerning the possibility of utilizing Waterton lakes for storage purposes makes the ultimate development uncertain, while the enlargement of the main canal of the Alberta Railway and Irrigation Company is an expensive item of cost. Further than this, the cost of irrigating several of the small tracts is high, owing to the long lengths of canal necessary to carry the water to them. It would seem that an economical development might be one comprising only those tracts which are most accessible to the source of supply.

Taking a broad view, however, and considering the future development, it should be realized that the only chance these comparatively expensive tracts have to receive water is by their inclusion initially in the main project, because while these tracts could be irrigated at an initial cost of about $40 per acre as a part of the greater project, the cost per acre to these lands, should they come in later by an extension, would probably be more than double this.

THE FOLLOWING IS A SUMMARIZED ESTIMATE OF COST FOR THE TOTAL DEVELOPMENT OF THIS PROJECT

No.	Item	Estimated Cost
		$ cts.
1	Waterton lake storage	960,382 90
2	Waterton river diversion canal	505,520 05
3	Belly river storage	456,505 40
4	Belly river diversion canal to Spring coulee	1,674,240 75
5	Enlargement of Alberta Railway and Irrigation main canal to div. gates in 6-5-22	585,150 50
6	Enlargement of Alberta Railway and Irrigation Magrath lat. and N. Magrath Distr. system	173,620 45
7	Milk river res. feeder canal and S. Magrath Distr. system	935,992 27
8	Milk River reservoir complete	688,816 30
9	Main canal Milk River reservoir to Verdigris reservoir and Middle Coulee Distr. system	698,791 27
10	Verdigris reservoir complete	407,168 00
11	Extension Milk River Div. canal and Warner and Milk River Distr. system	369,802 30
12	Verdigris outlet canal to div. gates, sec. 29-3-4 and distributaries	147,951 10
13	Pakowki canal and distributary system	769,940 75
14	Foremost canal and distributary system	763,082 61
15	Spillway and ditch Verdigris res. to Milk river	32,673 25
16	Canal connecting Milk river and Raymond res. and S. New Dayton system	137,105 83
17	Raymond reservoir complete	295,754 00
18	North New Dayton system	279,483 69
19	Balancing canal and distributary system	150,442 88
20	Enlargement Alberta Railway and Irrigation canal Welling to Chin reservoir	1,582,239 75
21	Enlargement Alberta Railway and Irrigation Chin No. 1 lat. and Cameron Branch system	74,345 72
22	Main canal New Chin reservoir to div. gates in 20-8-14 and distributaries	875,207 34
23	S. Forty-Mile Distr. System	297,123 45
24	N. Forty-Mile Distr. System	325,664 50
25	Chin reservoir complete	208,079 19
26	Enlargement Taber main canal and distributary system	525,357 00
27	Burdett canal and distributary systems	674,810 97
28	Horsefly lake drainage and Belly river tract distr. system	89,894 06
	Total	14,685,146 28
	All the above estimates of cost include 10% for engineering.	
	Add 5%—contingencies to cover loose rock, solid rock, bonding, haul, etc	734,257 32
	Total	15,419,403 60

Total acreage developed 390,708 acres.

Cost per acre .... = $\frac{\$15,419,403\ 60}{390,708}$ = $39 47

Estimated cost Alberta Railway and Irrigation Distr. system 0 97

Total $40 44

NOTE.—Detailed cost estimates to distribute the water over the 54,046 acres additional area which can be irrigated in the Alberta Railway and Irrigation Company's tracts have not been made. This cost has been taken as $7 per acre, or a charge against the whole 390,708 acres (the total irrigable area in the project outside of the 79,671 acres now irrigated by the Alberta Railway and Irrigation Company) of 97 cents per acre.

TABLE OF RESERVOIRS IN CONNECTION WITH THE PROPOSED LETHBRIDGE SOUTHEAST PROJECT AS DESIGNED

Name	Location	Area	Capacity	Estimated Cost	Cost per ac.-ft.	Remarks
		acres	acre-feet	$ cts.	$ cts.	
Waterton lake	Tp. 1, Rge. 30, W. 4th M. & Glacier Nat. Park, U.S.A.	3,035	150,000	960,382 90	6 40	Present lake area 2,270 acres.
Belly river and Mami creek	Tps. 1 & 2, Rge. 28, W. 4th.	1,434	30,906	456,505 40	14 77	Area Belly R. res...... 725 Area Mami Ck. res.... 709 Total........... 1,434
Milk river	Tp. 5, Rges. 19 & 20, W. 4th	2,521	80,723	688,816 30	6 81	
Raymond	Tp. 5, Rges. 20 & 21, W. 4th.	892	16,933	295,754 00	17 46	
Verdigris	Tps. 3 & 4 Rges. 15 & 16, W. 4th M.	3,396	140,566	407,168 00	2 90	
Chin (Upper)	Tps. 7 & 8 Rges. 17 & 18, W. 4th M.	2,307	94,250	208,079 19	3 52	

NOTE.—Reference Chin storage. Present effective capacity Stafford Res.............................. 7,750 acre-feet.
Present effective capacity Upper Chin.............................. 35,170 "
Enlargement Upper Chin.............................. 59,080 "

Total capacity of Chin reservoirs.............................. 102,000 "
The cost of $208,079.19 as chargeable against the proposed enlargement of 59,080 acre-feet—$3.52 per acre-foot.

Proposed St. Mary Lake Reservoir.—The International Joint Commission at its session in Ottawa, October 6, 1921, recommended to the Governments of the United States and Canada respectively, the construction of an international reservoir at St. Mary lakes in the State of Montana. As a source of water supply for lands in the Lethbridge Southeast project the value to Canada of such a reservoir has long been recognized in the conservation of her share of the water of St. Mary river. The question of capacity is one which can best be settled by engineers of the United States and Canada familiar with the irrigation requirements of each country and with the physical features of the proposed site. Some study has been given to the question of capacity. The bases of this study are the ultimate diversion canal capacities anticipated by the United States and Canada respectively from St. Mary river. The most economical storage capacity, other things being equal, is that which will provide for the full capacity operation of these canals for the whole of the operating season, or sufficiently long to allow each country to divert its share of the flow. Further discussion of this problem is inadvisable at present, pending some decision by the respective governments upon the recommendation made by the International Joint Commission.

Proposed Waterton River Storage.—For the full development of the proposed Lethbridge Southeast project a large storage reservoir is required on the Waterton river, and in all estimates of the available water supply, canal capacity, and costs, it has been assumed that storage capacity of 150,000 acre-feet will be created by damming the Waterton river at the "Narrows" between the upper and lower Waterton lakes.

During the months of February and March, 1922, a complete contour survey was made of that portion of the proposed reservoir which lies in Canada. The water level of the lake is 4,161 feet and the area 2,269·7 acres. At an elevation of 4,217 feet, the superficial area would be about 3,000 acres and the corresponding capacity 150,000 acre-feet.

A dam of sufficient dimensions to impound this quantity of water was designed and a cost estimate made. The following is a summary of the estimated cost of development to 150,000 acre-feet capacity:

Estimated cost of proposed dam	$745,575 50
Damage to real property (in Canada)	47,750 00
Reconstruction of motor highway	950 00
Estimated cost clearing flooded area, land damages, etc.	75,500 00
Telephone line	3,300 00
Total:	$873,075 50
Engineering and contingencies	87,307 50
Total:	$960,383 00
Estimated cost per acre-foot capacity	6 40

Owing to the fact that Waterton lakes are situated in the National parks of both the United States and Canada there has naturally been strong opposition in both countries to the proposed reservoir. In view of this opposition a reconnaissance was made during the field season of 1921 of the Waterton river valley from the lakes to the proposed intake in the NW $\frac{1}{4}$ sec. 29, tp. 3, rge. 28. By means of a dam in sec. 1, tp. 3, rge. 29, W. 4th meridan approximately 60 feet in height with a top length of some 565 feet it is roughly estimated that 47,200 acre-feet of water could be stored. The total estimated cost of this development is $685,623, or at a rate of $14.52 per acre-foot capacity.

A number of other sites have been suggested but none are of sufficient capacity for the development of an adequate water supply from Waterton river.

Water Supply.—In estimating the available water supply a net duty of eighteen inches has been assumed and an irrigation factor of 80 per cent, or it has been considered that 80 per cent of the entire irrigable area will require a depth of eighteen inches of water every year distributed throughout the season as follows:—

May	2 inches (net)
June and July	12 " "
August	2 " "
September	2 " "

Absorption losses were estimated in canals at the rate of six second-feet per million square feet of wetted area, with the exception of distributaries to a few of the more sandy tracts where eight second-feet were allowed.

A very complete study of the amount of water available from the Waterton, Belly, St. Mary and Milk rivers has been made for the period 1912 to 1920 inclusive, but is too voluminous for publication. The study shows an adequate supply for the 487,379 acres in the project for each year with the exception of 1919 when there is a deficiency of 28,361 acre-feet (net), 9,000 acre-feet of which occur in the month of August and the remainder in September. The occurrence of two dry years in succession, 1918 and 1919, is the cause of this deficiency. Such conditions as obtained in these two years are evidently exceptional, but a study of the stream flow records shows that the conditions in the years 1905 and 1906 were even worse than in 1918 and 1919. The indications are that a shortage of water may occur possibly once in every ten or fifteen years when the lands cannot be supplied with a full duty. The water supply, however, is considered adequate. In operating the system it has been considered necessary to have the Chin reservoir full by the first of June every year and to supply all the tracts under it entirely from storage during the months of June and July.

Organization.—The first definite steps toward organization were taken by representative farmers and business men of the Magrath, Raymond and Stirling country, at a meeting held at Raymond on February 15, 1919, when it was decided to organize with a view to the early construction of works to irrigate certain lands of the proposed Lethbridge Southeast project directly tributary to proposed reservoirs known as the Milk river and Raymond. These sites are both in township 5, directly south of the town of Raymond. Since that time the movement has spread and a number of other districts have organized. The Southern Irrigation district, including the lands referred to above, has already been erected under the Irrigation Districts Act, while others are in course of erection. The settlement of the International Waterways Treaty, in so far as it affects the division of the waters of Milk and St. Mary rivers, has removed the greatest obstacle to further development. A decision to construct the proposed St. Mary lake reservoir recommended by the International Joint Commission and a settlement of the question of Canada's use of the Waterton lake storage would remove the last serious obstacles. The proposed districts now in process of organization and erection are only waiting for the Governments to point the way before taking further steps.

The Southern Irrigation District.—It was hoped by organizing this district that while most of the lands could be readily reached from the canal system of the Alberta Railway and Irrigation Company, the construction of some scheme independent of the proposed Lethbridge Southeast project, (possibly in co-operation with the Alberta Railway and Irrigation Company) might be effected, and with this in view the district was erected and trustees were appointed. Although this district gave every assistance to furthering the interests of the Lethbridge Southeast project as a whole, they also independently negotiated with the company. The result of these negotiations, however, has not yet led to any practical solution. The company was not disposed to enlarge its system, and since the district was not in a position to finance any such undertaking alone it was decided to await further developments. Little further progress has been made during the past two years. The construction of the proposed St. Mary lake reservoir would make such a scheme feasible. This district should, however, be developed and constructed in conjunction with, and as part of, the Lethbridge Southeast project.

The Proposed New Dayton Irrigation District.—A petition to organize and erect a district under the Irrigation Districts Act was properly signed and submitted to the Alberta Government on October 10, 1921. Owing however to the fact that there was not sufficient evidence to show that irrigation was feasible for this district, except as a part of the Lethbridge Southeast project, permission to erect such a district has not yet been granted and organization is at present at a stand-still pending the completion of the estimates of the Lethbridge Southeast project. Practically no progress has been made during the past year.

The Proposed Warner-Milk River District.—This district, like the New Dayton district, is at present at a stand-still pending the completion of the estimates of the Lethbridge Southeast project. No progress has been made since the submission to the Alberta Government of a petition on February 20, 1920, to erect a district.

The Proposed Masinasin District.—Petitions have been circulated for the erection of a district, but no further progress has been made. This district is now awaiting the completion of plans and estimates of the Lethbridge Southeast project.

RETLAW-LOMOND DISTRICT

A general description of the surveys already made of this district is given in the annual report for 1920-21. Previous surveys anticipated the extension of the Lethbridge Northern project to serve these lands, but the possibility of irrigating them from an enlargement of the Canada Land and Irrigation Company's system has always been recognized.

During the year Mr. M. H. Marshall made a study of the main canal system of the Canada Land and Irrigation Company and compiled an estimate of cost for an enlargement to serve approximately 100,000 acres in this district while Mr. R. S. B. Lillico made a cost estimate for a similar enlargement of the Lethbridge Northern system.

Mr. Marshall estimates the cost of the necessary enlargement of the Canada Land and Irrigation Company's system at $2,496,282, or approximately $25 per acre for the 100,000 acres served thereby. To this he adds $9.20 per acre, the estimated cost of the lateral system necessary to serve this area, making a total constructional cost of $34.20 per acre.

The cost of the necessary enlargement of the Lethbridge Northern project, allowing for additional storage of 120,000 acre-feet on Oldman river, has been estimated by Mr. Lillico at approximately $3,140,590, or $31.40 per acre. To this must be added $9.20 per acre, the estimated cost of the necessary lateral system, making the total constructional cost $40.60 per acre.

It is estimated that there is sufficient water available from either Bow or Oldman rivers for the 100,000 acres in the Retlaw-Lomond district, but while in very dry years the supply from Bow river may become critical, an adequate supply from Oldman river would be practically assured each year.

These estimates of cost are based upon reconnaissance surveys and should not be considered as final. Further plane-table surveys of the district will be made during the field season of 1922 to definitely determine the irrigable area and to design and estimate the cost of the canal and lateral systems required.

PROPOSED NORTH RETLAW DISTRICT

The lands comprising this district are tributary to the canals of the Canada Land and Irrigation Company, and lie almost immediately north of the company's lateral "A" in township 13, range 17, west of the 4th meridian. Plane-table surveys were made of these lands and detailed plans and estimates have been completed.

The total irrigable area is 2,031 acres and the cost of construction of a lateral system from the Canada Land and Irrigation Company's main canal is $2.65 per irrigable acre. The total capital cost, including $40 per irrigable acre charged by the company as a proportionate share of the cost of the main canal, and an additional amount to cover the cost of organizing, financing and construction is estimated at $48.70 per irrigable acre.

The scheme is considered feasible, but no definite steps have been taken by the land owners to organize an irrigation district under the Provincial Act.

PROPOSED SOUTH RETLAW DISTRICT

The lands comprising this district lie in townships 11 to 13, range 17, west of the 4th meridian. The area is divided topographically into two blocks, one lying to the north and the other to the south of the Canadian Pacific railway, Lomond branch. Plane-table surveys were made of the whole of the area during the season and detailed plans and cost estimates have been completed.

The estimated irrigable area in the northern tract is 3,475·7 acres and in the southern tract 2,217·2 acres. Water can be diverted to these lands from

a point on the canal of the Canada Land and Irrigation Company above the drop in section 23, township 13, range 18. The estimated capital cost to develop the northern area is $241,815.00, or $69.57 per acre, and the southern area $127,944.00, or $57.70 per acre. In view of the high capital cost and the rolling character of the land in the northern tract, this portion of the scheme is not at present considered feasible. The southern tract forms a part of the Retlaw-Lomond project and it is not considered advisable to recommend the erection of this district until the surveys and estimates for the larger project have been completed.

PROPOSED TIDE LAKE SCHEME

A reconnaissance was made of certain lands in townships 18 to 21, ranges 8 to 11, in the vicinity of the Tide Lake, Alberta, with a view to extending the canals of the Canadian Pacific Railway Eastern Section tract to serve them. It was found impracticable to irrigate these lands by the extension proposed. The possibility of irrigating these lands either by pumping from the Red Deer river or by an extension of the proposed North Saskatchewan project will be investigated during the coming field season.

PROPOSED NEW WEST IRRIGATION DISTRICT

The lands comprising this district lie almost wholly in the west half of township 14, range 16, west of the 4th meridian and are tributary to and will receive their water supply through the canals of the the Canada Land and Irrigation Company. Plane-table surveys were made of this district during the season and detailed plans and cost estimates have been completed.

The total estimated irrigable area is 4,518·6 acres. The estimated capital cost of development is $228,666.94 or $50.61 per irrigable acre.

This district is now in process of organization and the plans have been approved by the Minister of the Interior subject to some minor changes which will be made.

PROPOSED EYREMORE DISTRICT

Surveys were made of certain lands in townships 16 and 17, ranges 16 and 17, west of the 4th meridian, tributary to the canal system of the Canada Land and Irrigation Company. This district comprises an area of 4,092 irrigable acres of first class land. Detailed plans and cost estimates of this scheme have been completed. The capital cost of the development including estimated charges for organization, financing and construction is $61.40 per irrigable acre. The cost is higher than the interested land owners had expected and they are undecided as to the advisability of forming a district.

PROPOSED RIVER BOW DISTRICT

This district lies immediately south of the Eyremore district. Plane-table surveys were made during the season and detailed plans and cost estimates have been completed.

This district, like the Eyremore district, is tributary to the canals of the Canada Land and Irrigation Company and will receive water through that system.

The total irrigable area is 5,791·9 acres. The estimated capital cost is $314,357.00, or $54.27 per irrigable acre. No petitions have yet been presented for the formation of this district and no recommendations in regard to the scheme have been made.

PROPOSED PEARCE IRRIGATION DISTRICT

Surveys were made of certain lands in townships 9 and 10, ranges 24 and 25, west of the 4th meridian, in the vicinity of Pearce, Alberta, with a view to irrigating them by pumping water either from Oldman river or from the canal system of the proposed Macleod district. Various schemes were investigated and comparative cost estimates have been prepared. It was found that the cost is excessive and the scheme is not recommended as feasible.

PROPOSED BEAVER CREEK SCHEME

As a result of petitions presented by residents of the Tennessee, Hilsboro, Ashdale and Summerview districts a reconnaissance was made during 1920 to determine whether or not it is possible to irrigate their lands. The result of their reconnaissance briefly stated is as follows:—

1. It is not feasible to irrigate lands in the above location from Oldman river.
2. It is quite feasible to divert water for irrigation from Tennessee and Beaver creeks.
3. There is an area of approximately 9,000 acres tributary to Beaver creek which can be irrigated provided there is sufficient water for this purpose.
4. In order to irrigate any considerable area of land from either of these creeks storage is necessary.

From the character of the drainage basins of these creeks it was expected that storage could be created cheaply. A further reconnaissance made of the headwaters of Beaver, Five Mile and Nine Mile creeks proved, however, that there are no natural sites where water can be stored cheaply. Only one site was found which was considered worthy of further investigation; this was on Five Mile creek in township 9, range 26, west of the 4th meridian. A complete survey was later made of this site. A tentative study was also made during the year of the available water supply from Beaver creek and cost estimates of a tentative scheme to irrigate some of the area tributary to Beaver creek were prepared.

It was estimated that with the available storage on Five Mile creek, about 3,500 acre-feet, there might be sufficient water for 2,600 acres of land. A tentative design was made anticipating a development of sixty-five quarter-sections, each with forty acres or less irrigable. The constructional cost of such a scheme was estimated at $55.30 per irrigable acre. During 1921 detailed surveys were made of this scheme and detailed plans and cost estimates have since been prepared. The following is a summarized cost estimate of the proposed development:—

Headgates, weir, wing walls and earth fill	$ 6,895 20
Main canal	22,143 50
Laterals	11,597 74
Total	$ 40,636 44
Estimated cost of reservoir	85,000 00
	$125,636 44
Engineering and contingencies	18,845 47
Total	$144,481 91

Or $55.56 per acre.

PROPOSED FLOOD SCHEME FOR THE MEDICINE HAT EASTERN IRRIGATION DISTRICT

On February 24, 1921, an order for the formation of the Medicine Hat Eastern Irrigation district was made by the Alberta Government, under the provisions of the Irrigation Districts Act, 1920. On April 12, 1921, Mr. George G. Anderson, Consulting Engineer of the Provincial Government, reported on the proposed project. He recommended that the government should not undertake to guarantee the bonds on account of alleged inadequate water supply. The district then employed Mr. D. W. Hays to report on the project and to prepare a modified plan that would appear more feasible from a water supply point of view. On July 26, 1921, Mr. Hays' report was submitted, but he did not suggest any modified plan, as he was of opinion that any storage project on Ross creek was risky from a commercial standpoint.

In November, 1921, the district requested this department to investigate the feasibility of utilizing flood waters to irrigate their lands, without using reservoirs, and the necessary further investigation was made during the following month.

The district has been revised so as to create two small flood irrigation schemes, one diverting from Ross creek and serving some 1,338 acres situated one and one-half miles north of the Canadian Pacific Railway station at Dunmore and two miles east of Medicine Hat, and the other from Bullshead creek irrigating some 1, 600 acres lying adjacent to the Canadian Pacific railway and three miles south of Medicine Hat. The district includes a gross area of some 4,800 acres, of which it is proposed to irrigate some 2,938 acres.

Soil and Surface Conditions.—The soil in the area to be served from Ross creek, as well as that from Bullshead creek, is a light sandy loam suitable for irrigation. The soil in the area under the proposed Bullshead creek canal has already shown signs of drifting. Each quarter-section included in the district has been carefully examined and the areas classified as irrigable can be controlled, are suitable for, and will be greatly benefited by irrigation.

Climatic conditions.—The average temperatures for Medicine Hat over a period of thirty-seven years have been worked out and are submitted hereunder for the months of April to August, the growing season. These temperatures are higher than those for the Calgary, Edmonton and Lethbridge districts:—

	Mean of 37 years.
April	45·1°
May	54·5°
June	62·9°
July	68·5°
August	66·7°

The elevation of the district varies from 2,300 to 2,600 feet above sea-level.

Rainfall.—The average monthly rainfall over a period of thirty-seven years for the months of April, May, June and July, which are the months chiefly affecting crop growth for the year, are given hereunder:—

April	0·66	inch
May	1·70	inches
June	2·53	"
July	1·80	"
Total	6·69	"

From the records of the wheat yields in relation to rainfall, which have been compiled from the available records of wheat yields of this province, it is observed that the average yield per acre during a period of sixteen years has been 14·2 bushels, and, if the years 1915 and 1916, which were exceptionally good ones, are eliminated, the average yield will equal only 11·6 bushels. During the past five years the yield per acre has averaged about eight bushels.

Water Supply—Ross Creek.—The proposed point of diversion from Ross creek is in the SW. ¼, sec. 8, tp. 12, rge. 3, W. 4th mer. and the 1,338 acres which can be irrigated would be served by means of a canal some eight miles long with a capacity of 51·66 cubic feet per second. No storage is proposed in connection with this scheme. The records of stream flow indicate that during an average year, allowing for an 80 per cent irrigation factor, sufficient water for an eight-inch duty could be diverted at high stages of flow. The ditch proposed would have a capacity capable of supplying a twelve-inch duty to 100 per cent of the land, and it would appear that in favourable years this would be available from high and flood stages as follows:—

1,338 acres at 12-inch duty..	1,338	acre-feet
Absorption losses..	446	"
Total..	1,784	"
In a normal year the supply from high stages would be..	1,100	"
Required from flood stages..	684	"
Total..	1,784	"

By taking individual years and considering that the water will have to be applied during the short and varying periods when it is available—beneficial use can be considered about as follows:—

1911—12 inches, April, June and September.
1912—12 inches, April, May, June and September.
1913—8 inches, April and May.
1914—8 inches, April and May.
1915—8 inches, benefit questionable, sufficient rainfall.
1916—8 inches, benefit questionable, sufficient rainfall.
1917—8 inches, April and May.
1918—8 inches, April.
1919—0 inches.
1920—8 inches, April and May.
1921—12 inches, April and May.

From the rainfall records at Foster's ranch, near Seven Persons, during 1915-1916, it is doubtful whether any irrigation was required, as will be seen from precipitation records given hereunder:—

	1915 Inches	1916 Inches	Normal 1911-1917 Inches
May..	1·68	2·71	1·27
June..	4·14	6·21	3·74
July..	4·07	4·13	1·63
August..	0·92	5·41	1·91
	10·81	18·46	8·55

Water Supply—Bullshead Creek.—The proposed point of diversion from Bullshead creek is on the SE. $\frac{1}{4}$ sec. 29, tp. 11, rge. 5, west of the 4th meridian. The land to be benefited is some 1,600 acres of sandy loam soil lying just west of Dunmore. In this case the irrigable land lies much closer to the proposed point of diversion—control being obtained with only two miles of main canal.

With a canal capacity of 51·76 c.f.s., and assuming an irrigation factor of eighty per cent of the 1,600 acres, the available records indicate that an eight-inch duty would be available for eight years out of ten. Owing to lack of storage and the short and fluctuating duration of flow a greater quantity cannot be granted. During the year 1919 the available supply was scarcely more than sufficient to prime the canals, and during 1914 there would not have been sufficient for any practical irrigation, after deducting prior appropriations and allowing for riparian rights.

This indicates that during possibly two years out of ten the scheme would be of little direct value, but as it can be constructed at small cost per acre the benefit during normal years would be considerable. Some moisture might be retained in the soil from one year to another; this condition occurs in the case of heavy soils, but with sandy soils such as those under consideration, the favourable effect would be less marked, especially where the subsoil is very porous. Although alkali conditions are not anticipated it would be well to make tests.

Consideration should be given to the fact that a very high percentage of the water available from both sources must be diverted during April. This is often very early in the year for successful irrigation in most parts of Alberta, as the ground is liable to be frozen. However, conditions in this particular district are exceptional and in most years irrigation can be applied beneficially during this month. In fact, a great deal of consideration has been given to the successful results which have been obtained in this vicinity by Messrs. Starks and Burton who have operated their irrigation project from Bullshead creek under precisely similar conditions for the past fifteen years.

From experiments which have been carried on by this department for a number of years at the Brooks Experiment Station it has been ascertained that twelve inches of water are required to produce the first ton of alfalfa hay. With twelve inches of water applied by irrigation and supplemented with an average of from five to six inches from precipitation during May, June and July, it is estimated that a yield of two tons of alfalfa per acre is possible.

Works—Ross Creek Diversion.—The works in connection with the diversion from Ross creek will consist of a reinforced concrete diversion dam in the SW. $\frac{1}{4}$ sec. 8, tp. 12, rge. 3, west of the 4th meridian. This dam could be of simple and inexpensive design with flash board control. The total concrete has been estimated at twenty-three cubic yards. There do not appear to be any special difficulties in connection with the construction of a dam at this point.

The main canal commences at a point adjacent to the dam and continues westward for some eight miles until the irrigable area is reached. The principal drawback to this part of the general scheme would appear to be the length of canal necessary before control is obtained. No excessive cutting would be necessary on the main canal.

Cost—Ross Creek Diversion.—The estimated cost of construction per acre for the area to be benefited is $12.93. This will construct a scheme which will ensure an annual application of twelve inches of water in eight years out of ten according to existing records.

Works—Bullshead Creek Diversion.—The works in connection with the diversion from this creek will consist of an inexpensive reinforced concrete

dam in the SE. $\frac{1}{4}$ sec. 29, tp. 11, rge. 5, west of the 4th meridian. From this point the main canal will follow a northeasterly course for one mile, thence across a natural coulee and thence northwesterly until the irrigable area is reached, a distance of some two miles from the point of diversion. A crossing of the Canadian Pacific railway is required in the SW. $\frac{1}{4}$ sec. 6, tp. 12, rge. 5, and the estimates have allowed for two concrete pipes at this point. Other structures required will be of simple and inexpensive design.

Cost—Bullshead Creek Diversion.—The cost per acre for the necessary works has been estimated at $6.50. This is for a scheme which will give eight inches of water to each acre of land during eight years out of ten, according to records now available.

The trustees of this district are not entirely satisfied with the location of the reduced areas which will be benefited under the amended scheme and have requested a further investigation to be made to determine the possibilities of irrigating some of the adjoining areas. This work is now being undertaken and a further report and estimate will be submitted for their consideration at an early date.

MEDICINE HAT SOUTHERN IRRIGATION DISTRICT

An outline of the system which was designed for this district, together with an estimate of cost, was published in the 1920-21 report. Notice of application to form an irrigation district in accordance with the provisions of the Irrigation Districts Act was published in the *Alberta Gazette* of February 28, 1920, and the district was duly erected; officers were appointed 11th January, 1921, and notice published in the *Alberta Gazette* on the 31st January, 1921.

On April 13, 1921, Mr. George Anderson, a consulting engineer, of Denver, Colorado, reported on the project on behalf of the Provincial Government. He recommended that the district be not assisted by the province, as in his opinion the water supply did not justify it. The district officials were not satisfied with this report and employed Mr. D. W. Hays, of Medicine Hat, Alberta, to make a report on the project and to outline a scheme that would be free from this objection. On July 18, 1921, Mr. Hays submitted a report to the district and suggested that the irrigable area be reduced to 3,000 acres and that each unit contain at least eighty irrigable acres. Following these suggestions further field work was undertaken and a report and estimate were submitted by Mr. C. M. Moore from which the following is quoted:—

> "The water for this proposed project is that which finds its way into Sevenpersons and Paradise creeks from the melting of the winter's accumulation of snow—a heavy rainfall seldom causes any run-off. The catchment area above the proposed reservoir covers 529 square miles, most of which forms the western slopes of the Cypress hills. The drainage basin lies some thirty-five miles south of Medicine Hat, Alberta, and its elevation ranges from 2,500 to 4,000 feet above sea-level.
>
> "It is proposed to divert the normal flow of Paradise creek into Sevenpersons reservoir No. 2, to augment the supply from Sevenpersons creek.
>
> "The average annual precipitation at Medicine Hat for the past thirty-six years was ten inches and varied from 5·11 inches in 1886 to 23·28 inches in 1899. The precipitation from September 1 to April 30 over the same period averaged 5·2 inches.
>
> "The yearly mean temperature at Medicine Hat for the last thirty-one years was 42° Fahr. as compared with 37° at Calgary. The average mean temperature for May to September inclusive was 62° at Medicine Hat and 56° at Calgary.

" Paradise creek joins Sevenpersons creek one mile east of the town of Seven Persons. The discharge measurements of Sevenpersons creek at Medicine Hat are available from 1913 to the present and have been carefully studied. The average rainfall from May 1 to August 30, for the last thirty-six years was 4·8 inches, which is only a fraction of the amount which the soil could absorb without causing any run-off (providing the showers were light). Frequent chinooks cause most of the snow to melt during the winter months and a run-off results, if the soil is frozen. It therefore appears that run-off bears little relation to precipitation in this drainage basin. In this report the period for which run-off data are available will be accepted as indicating the conditions that may be expected in the future.

" The site of Sevenpersons reservoir No. 2 is twenty-five miles southwest of Medicine Hat and at full supply level at elevation 2,513 feet has an area of 2,597 acres, at which elevation the available storage capacity is 12,259 acre-feet. The bottom of the lake forming the southern end of the reservoir has an elevation of 2,509 feet. At elevation 2,501 feet the area of the reservoir is thirty-nine acres and the capacity is 102 acre-feet.

" Since the greater part of the area covered by the reservoir will be exposed each year the seepage losses will be greater than in most reservoirs. The loss is estimated at 3·23 inches per month over the water area. The average rainfall per month since 1884 is 0·83 inch which leaves 2·4 inches, or 0·2 foot per month, to be lost by seepage over the entire water area of the reservoir. The temperature in this district is relatively high and the evaporation losses in the reservoir would approximate 0·2 foot in January, February, March, November and December. 0·3 foot in April and October, 0·4 foot in May and September, 0·6 foot in July and August, and 0·5 foot in June.

" The required works consist of an earth dam with a concrete spillway on Paradise creek in sec. 1, tp. 10, rge. 7. From this point a canal leads westward about five miles with a capacity of one hundred cubic feet per second. A drainage ditch would be necessary to drain the lake which forms the southern end of the reservoir.

" Sevenpersons reservoir No. 2 would require a dam similar to that mentioned above as well as a concrete outlet pipe with gates and a control tower. The remainder of the structures would be of standard design. Two sets of farm buildings would require removing.

" The irrigable area lies on the east side of Sevenpersons creek and is contained in thirty-nine quarter-sections scattered over a distance of nine miles beginning near the reservoir. Thirty-three of these quarters are to have eighty acres, and the remaining six quarters lying adjacent to the creek sixty acres, commanded. The thirty-nine quarters are owned by sixteen different persons, the largest individual holding being twelve quarters; eight persons own one-quarter section each. Of the sixteen owners, six cultivated a portion of their land during the past year and two owners reside on their holdings. The quarters included in the district are those owned by the original petitioners. At the northeastern limits of the district preference is given to cultivated lands where no extra expense would be incurred to the district.

" The irrigable area within six miles of the reservoir falls to the north at about thirteen feet per mile with a uniform slope. The surface soil is sandy loam and at scattered points the subsoil of fine clay is exposed. This fine clay contains a small percentage of alkali and the advisability of irrigating such exposed areas is receiving attention. How-

ever, about eighty acres of each quarter show no alkali-bearing soil exposed. The remainder of the irrigable area appears to possess a considerable depth of sandy loam on the surface. This portion falls more rapidly to the north and is slightly rolling. It contains small knolls and it is doubtful whether some quarters would contain many more than eighty irrigable acres.

"The estimated cost of construction and right of way is $52.47 per irrigable acre."

This amended scheme was developed upon request of the district and with the idea of devising the most economical system for the water supply available for an area of 3,000 acres, as suggested in the report submitted by Mr. D. W. Hays, and referred to above.

In view of the conditions of land ownership, etc., and of the fact that a study of the available records indicates that a supply sufficient to apply from fifteen to eighteen inches in depth would only be available during seven out of nine years, further investigation is deemed necessary. It has therefore been decided to defer further action towards recommending the reservation of the necessary water for the project until more information regarding water supply has been obtained.

PROPOSED WILLOW CREEK SCHEME

As a result of petitions presented by residents in townships 9 and 10, range 27, west of the 4th meridian, between Willow and Kyiskap creeks, a reconnaissance was made during 1921 to determine the possibilities of irrigating these lands. The result is as follows:—

1. The controlling feature is a high cutbank on the west side of Willow creek just opposite to the town of Granum in section 36, township 10, range 27, and that in order to command the lands the main canal must be at a sufficiently high elevation to avoid this.

2. The proposed intake must be either on Trout creek or on Willow creek above the mouth of Trout creek.

3. The lands which would be commanded by such a scheme are in every respect suitable and irrigation would be most beneficial.

4. To irrigate lands from either Trout or Willow creeks, storage would be required.

A reconnaissance was made of both Trout and Willow creeks with a view to locating storage sites. Only two sites were located, one on Trout creek in sections 27 and 34, township 11, range 28, and the other on a branch of Willow creek just above the "Bar U" ranch in section 6, township 14, range 29.

Detailed surveys of this scheme were made later by Mr. N. M. Sutherland and detailed plans and cost estimates have since been completed. The following is a summarized cost estimate of this proposed development:—

Weir and intake, Muddypound creek..	$ 1,850.45
Main canal..	23,547.30
Laterals..	13,037.67
	38,435.42
Engineering and contingencies—15 per cent.. ..	5,765.31
	44,200.73
Reservoir—Trout and Muddypound creeks..	215,796.72
Total..	$259,997.45

E F George

Total irrigable area = 4,472 acres.
Total cost per acre = $259,997.45 ÷ 4,472 = $58.14.
Cost of canal system per acre = $44,200.73 ÷ 4,472 = $9.88.
Cost of reservoir per irrigable acre = $215,796.72 ÷ 4,472 = $48.25.
Capacity of reservoir = 7,659 acre-feet.
Cost of reservoir per acre-foot = $215,796.72 ÷ 7,659 = $28.18.

A study has been made of the available water supply from Willow, Trout and Muddypound creeks. This shows in the case of Willow creek that although the yearly discharge is sufficient to provide for the requirements of the present applicants and also for the lands of the proposed Willow creek scheme of Granum district, in dry years the discharge for the months of July, August, and September falls below the rate required. To assure a full duty of water during these periods, storage is necessary. In the case of Trout and Muddypound creeks the records show that during about fifty per cent of the years for which records are available the discharge of these streams during the summer months is insufficient and storage for the entire combined yearly run-off is required. The critical years are 1918 and 1919 and the following table shows the operation of the proposed storage reservoir on Trout creek for these years, estimating the storage capacity of this site at 7,660 acre-feet. Considering the period of nine years, 1911 to 1919 inclusive, it is found that with the proposed Trout creek reservoir it will be possible to provide the estimated monthly requirements throughout, with the exception of four months during 1919 and a short period during 1918. In view of this it would seem that the proposed scheme is feasible from a water supply point of view.

PROPOSED GRANUM IRRIGATION DISTRICT

TABLE Showing Operation of Reservoir on Trout Creek

Year	Period	Discharge of Trout Creek	Required for small schemes	Discharge of Muddypound Ck.	Required for small schemes	Run to storage	Required for Granum Dist.	Remaining in storage	
		ac.-ft.	ac.-ft.	ac.-ft.	ac.-ft.	ac.-ft.	ac.-ft.	ac.-ft.	
								7,660	Carried over.
1918....	April.......	1,142	....	208	670	....	....	7,660	
"	May........	855	389	84	84	422	422	7,660	Quail res. filled.
"	June........	1,018	778	55	55	240	2,531	5,369	
"	July........	652	652	5	5	....	2,531	2,838	
"	August......	387	387	2	2	....	1,687	1,151	
"	September..	399	389	25	25	10	1,266	....	Shortage=105 ac.-ft.
"	October....	769	....	30	30	769	....	769	
" .... 1919....	Nov. to Feb........	400	....	....	....	400	....	1,169	
"	March......	191	....	111	....	302	....	1,470	
"	April.......	815	....	208	208	815	....	2,286	
"	May........	1,058	778	55	55	280	422	2,144	
"	June........	553	553	3	3	....	2,531	....	Shortage=387 ac.-ft.
"	July........	209	209	....	....	....	2,531	....	2,531 "
"	August......	178	178	....	....	....	1,687	....	1,687 "
"	September..	161	161	....	....	....	1,266	....	1,266 "

PROPOSED MANYBERRIES CREEK RESERVOIR

Investigations into the possibilities of storage on Manyberries creek in the early months of 1921 resulted in the location of a reservoir site covering part of the following sections:—

Sec. 34, tp. 4, rge. 6; secs. 2, 3, and 11, tp. 5, rge. 6; the dam site being in the NW. ¼ sec. 34, tp. 4, rge. 6, W. 4th mer. A plane-table survey was made of the site in August, 1921, elevations being on the original irrigation datum.

Approximately 4,000 acres of hay lands are irrigable below the reservoir, but as about one-half of the total annual run-off takes place in April it would only be possible to cover the whole irrigable area during this month. The average run-off in May is slightly in excess of 500 acre-feet, and in June about the same. At present an area considerably less than 4,000 acres is being irrigated below the reservoir, chiefly with one flooding during the March or April peak. Very little irrigation is attempted after the end of April in normal years, as the flow of the stream averages only about eight second-feet. With some provision for storage a larger area could be irrigated, and the water could be applied when required, which would increase the yield from the irrigated land considerably, and also make possible the growing of alfalfa and other crops requiring frequent applications of water.

The mean annual run-off for the period 1911-21 is 7,200 acre-feet, but as the records are incomplete it is probable that the actual mean run-off is somewhat greater.

Assuming a total irrigable area of 4,000 acres, net duty fifteen inches, and allowing for canal and reservoir losses and an irrigation factor of eighty per cent, it is thought that storage capacity of 11,000 acre-feet is sufficient to ensure an adequate supply of water for conditions equal to the driest recorded period. From the point of view of economy in the reservoir this is also a suitable figure, the cost of storage for any less quantity being greater per acre-foot stored. For any greater quantity the cost per acre-foot stored would be about the same, as the content of the dam increases rapidly without any considerable increase in the surface area of the reservoir.

Following is a summarized estimate of cost of a reservoir with a capacity of 11,000 acre-feet:—

Earth fill, 242,000 + 10 per cent = 266,200 c. y. at $25..	$ 66,550 00
Riprap, 14,500 sq. yds. at $2 per sq. yd..	29,000 00
Stripping, 25,000 sq. yds. at $10 per 100..	2,500 00
Outlet works, cap. 50 c.f.s..	5,648 00
Spillway weir and chute, cap. 2,500 c.f.s..	14,935 00
Property damages, 550 acs. at $10..	5,500 00
	$124,133 00
Add 10 per cent contingencies, etc..	12,414 30
	$136,547 30
Cost per acre-foot for storing 11,000 acre-feet =..	$12 41
Cost per acre for irrigation 4,000 acres =..	34 14

PROPOSED CHAMPION IRRIGATION DISTRICT

The development of this project is the result of a reconnaissance made during 1920 of a scheme to supply water for the proposed Retlaw-Lomond district. It was found that under the proposed canal from the Highwood river to lake McGregor, which would be necessary to carry the water for the Retlaw-

Lomond district, there is a fairly large tract of good land (estimated at 58,000 acres) mostly in townships 14 and 15, ranges 22, 23, 24, 25 and 26, West of the 4th meridian which could be irrigated. A tentative study made of the records of Highwood river indicated an available water supply for not more than 50,000 acres. Since these lands are more entitled to the Highwood river water than lands of the Retlaw-Lomond district, the scheme has been confined to these lands, and is now known as the Champion district.

A reconnaissance was made during 1921 of the headwaters of Highwood river for the purpose of locating a suitable site in which to store the flood waters. A dam site which appeared to be suitable was located just above the mouth of Cataract creek. The river at this point flows through a solid rock canyon at what is locally called "Gunner's Grade" which makes an excellent site for a dam. Upon being further investigated it was found that to store anything like the required quantity of water (estimated at 60,000 acre-feet) the cost of development would be excessive.

Another site was located just northwest of the town of High River in what appears to be an old river channel. It was estimated that by constructing a forty- or fifty-foot earth dam here thirty to forty thousand acre-feet of water could be stored cheaply. In conjunction with a known reservoir site at Frankburg lake in township 16, range 22, just east of the town of High River, it was estimated that sufficient storage (60,000 acre-feet) could be developed.

Surveys of this scheme were later made by Messrs. Sutherland and McGillivray. The main canal and some of the distributaries were run, and section line levels over the irregular areas completed. Complete plane-table surveys will be carried on during 1922 and estimates and detailed plans will be prepared.

RESERVOIR SURVEY AT THE JUNCTION OF GAP AND MAPLE CREEKS

A survey was made of a proposed reservoir site at the above location and a plane-table survey also made of Tenaille or Sixteen Mile lake, it being considered that a very cheap reservoir site might be developed here for the purpose of regulating the flow of Maple creek and providing water for schemes already developed or contemplated along the creek towards Bigstick lake.

The investigation of this site showed that a reservoir with a capacity of 4,220 acre-feet could be developed at a cost of approximately $5.40 per acre-foot and that the cost of storage per irrigable acre for 3,000 acres would be approximately $7.60, the total estimate being $22,980.

It is proposed under this scheme to divert the available waters of Maple creek into a natural channel leading to Tenaille or Sixteen Mile lake by means of a headgate in the right bank of Maple creek. The natural channel will require enlarging and improving. A system of dykes averaging seven feet in height will be required to control the water. The general topographic features are such that a storage reservoir can be developed with reasonable expenditure. The bed of the lake is composed of heavy impervious clay and seepage losses should be negligible. The evaporation losses during May, June and July have been estimated as follows:—

	Acre-feet
May—3-inch loss on mean surface	230
June—5-inch loss on mean surface	320
July—5-inch loss on mean surface	190
	740
Add irrigation requirements	4,000
	4,740

This total is about 500 acre-feet in excess of the reservoir capacity figured, but an additional six inches of storage would take care of this deficit. The evaporation losses on the dead water surface of the lake after emptying the reservoir would be approximately 600 acre-feet up to March of the succeeding year. A total diversion from Maple creek of approximately 5,300 acre-feet will be required to offset these losses and provide for irrigation requirements on a basis of a twelve-inch net irrigation on 3,000 acres during May, June and July.

SURVEY OF MAPLE CREEK FLATS

A survey was made of certain lands in the vicinity of the town of Maple Creek, with a view to irrigating them from Maple creek and Gap creek. Canals to serve these lands were run out from both creeks and a complete topographical survey made of the lands commanded. Reservoir sites were surveyed on these creeks at points where it was considered that storage might be created. The reservoir sites surveyed are at the following locations:—

Gap creek, sec. 27, tp. 10, rge. 27, West 3rd meridian.
Maple creek, sec. 7, tp. 10, rge. 26, West 3rd meridian.
Downie lake, secs. 1, 2, 11 and 12, tp. 10, rge. 28, West of the 3rd meridian.

A final study of this development has not yet been completed. There is considerable doubt as to the suitability of these flats for irrigation. The soil consists of a very heavy clay containing some alkali. An investigation of the soil conditions was made during the season by Dr. Shutt, Dominion Chemist, but the results of his investigation are not yet known. Topographically, there are no serious obstacles to this development but considerable storage is required for the irrigation of even a comparatively small area.

IRRIGATION SURVEY BENCH-MARKS IN ALBERTA AND SASKATCHEWAN.

REDUCED TO MEAN SEA LEVEL DATUM

A large number of permanent iron bench-marks were established during the field season 1911 over a wide area in the two provinces covered by irrigation surveys. A considerable number had been previously established by earlier surveys, but these were found to differ considerably from the elevations established by the Geodetic Surveys of Canada and were probably taken from Canadian Pacific Railway track elevations.

A record has been compiled showing all the bench-marks which have been established from 1911 to 1921 inclusive. They have been numbered consecutively and the location given by section, township, range and meridian for easy reference. The elevations have all been reduced to mean sea-level datum, which in many cases has been made possible through the co-operation of the officials of the Geodetic Surveys Branch, Department of the Interior.

All the bench-marks are of the standard type which has been adopted by the Irrigation Division of the Reclamation Service.

This record is to be published separately in pamphlet form for more convenient reference.

REPORT ON DUTY OF WATER INVESTIGATIONS FOR 1921—SUMMARY OF RESULTS OBTAINED AT BROOKS, VAUXHALL AND COALDALE.

Seeding was started on April 19, but owing to low temperature in April and May growth was slow. Frost occurred on twenty-four nights in April and six in May, the last occurrence in May taking place on May 28.

The total precipitation, April to September inclusive, was 8·26 inches or nearly double that of 1920, which had a total of 4·97 inches. The mean temperature for the period was 56·2°.

On the whole the season was backward, due to a dry spring and the low mean temperature and rather cold, wet fall. Drought and hot winds in June did considerable damage to crops, especially where insufficiently irrigated.

The results of the past season's work are given in the following tables.

In studying the tables it is to be noted that the column *Total Depth Received* is the sum of the *Duty of Water* and *Precipitation*. The column *Total Depth Used in Growing the Crop* shows the depth of water actually used in growing the crop as determined by soil moisture tests.

DUTY OF WATER INVESTIGATION AT BROOKS

The following tables show the rotation schedule adopted at Brooks in order to maintain the general fertility of the farm, and so that certain crop series may have from year to year, as nearly as may be, the same conditions of soil fertility.

For 1921 the duty of water for wheat has been determined under three different conditions of soil fertility: (1) immediately following a leguminous crop; (2) following oats, after peas—beets; (3) following barley after oats—potatoes. In a similar manner the duty of water for oats is found under four different conditions of soil fertility, barley under three, and potatoes under two.

Rotation A.—Alfalfa five years, potatoes, wheat, flax.
" B.—Alsike clover four years, roots, oats (*a*), wheat, oats (*b*).
" C.—Grass three years, potatoes, barley, wheat.
" D.—Red clover two years, oats, barley.
" E.—Peas, wheat, oats, barley.

From this schedule it is possible to have in each season grain crops (wheat, oats or barley) coming immediately after legumes and grasses, second year after legumes, and third year after legumes. This gives an opportunity of securing practical evidence of the phenomena that crops growing on fertile soil require less water to produce a maximum yield than when growing upon soils where, because of successive cropping without the introduction of organic matter or legumes, the available plant food has been materially reduced.

Wheat.—In rotation "E" the maximum yield of 42·5 bushels per acre was produced under a total depth received of 1·92 feet.

In rotation "C" the maximum yield of 34·9 bushels per acre was produced under a total depth received of 2·09 feet.

In rotation "B" the maximum yield of 39·0 bushels was produced under a total depth received of 2·42 feet.

Summarizing the results from the three wheat series, it is shown that the maximum yields were produced with an average total depth received of 2·14 feet, of which 0·42 was rainfall. In each series, with the exception of that in rotation "B" where the maximum yield of 39·0 bushels coincides with the maximum application on plot 69-E, additional irrigations produced a decrease in yield. The dry plots gave some straw but no grain. The maximum yield of the three series, 42·5 bushels per acre, with a total depth received of 1·92 feet, was from land which grew peas in 1920.

Oats.—In rotation "D" the maximum yield of 143·0 bushels per acre was produced under a total depth received of 2·09 feet. In rotation "B" (*a*) the maximum yield of 138·1 bushels per acre was produced under a total depth received of 1·92 feet. In rotation "E" the maximum yield of 91·2 bushels per acre was produced under a total depth received of 2·39 feet. In rotation "B" (*b*) the maximum yield of 84·7 bushels per acre was produced under a total depth received of 2·06 feet.

Summarizing the results from the four oat series it is shown that the maximum yields were produced with an average total depth received of 2·11 feet. of which 0·42 foot was rainfall in "D" and "B" (*a*) and 0·39 foot was rainfall in "E" and "B" (*b*). In all series except "E" excessive irrigation gave decreases in yield.

The maximum yield of the four series, 143 bushels per acre, with a total depth received of 2·09 feet, was from land which grew clover in 1920.

Flax.—The flax plants suffered from wilt and the results from the application of the irrigation schedule were so unreliable that the data were discarded.

Barley.—In rotation "E" the maximum yield of 49·2 bushels per acre was produced under a total depth received of 1·69 feet. In rotation "D" the maximum yield of 60·5 bushels was produced under a depth of 1·69 feet. In rotation "C" the maximum yield of 52·0 bushels per acre was produced under a total depth received of 1·69 feet.

Summarizing the results from the three barley series it is shown that the maximum yields were produced under an average total depth received of 1·69 feet, of which 0·35 foot was rainfall. The dry plots produced no yield.

Alfalfa Seed Production.—The maximum yield of alfalfa seed, 3·7 bushels per acre, was produced under a total depth received of 1·57 feet, of which 0·57 foot was rainfall. This yield was produced from that portion of plot "41-E" which was seeded in hills. It was coincident with the maximum depth applied. The dry plot and plot "41-B", which received one 3-inch irrigation, produced no seed.

Where the alfalfa seed was sown in rows, the maximum yield, 2·38 bushels per acre, was produced under a depth received of 1·57 feet. The dry plot and the plot receiving one irrigation produced no yield.

Where the alfalfa was sown in drills, the maximum yield, 3·20 bushels per acre, was produced under a total depth received of 1·57 feet. The dry plot and the plot which received one irrigation produced no yield.

The past season was very unfavourable for the production of alfalfa seed. Late frosts damaged the blossoms, which did not set well. The seed all through the Brooks district germinated very low and had a high percentage of hard seeds.

Peas.—The maximum yield of peas, 60·3 bushels per acre, was produced on plot "20-A" under total depth received of 2·47 feet. The dry plot produced no yield. Plots "20-B" and "20-C", which received total depths of 2·81 and 3·14 feet, produced decreasing yields, 58·4 and 57·2 bushels respectively.

Potatoes.—In rotation "A" the maximum yield, 421 bushels per acre, was produced under a total depth received of 1·69 feet of which 0·69 foot was rainfall. The non-irrigated plot produced at the rate of 120 bushels per acre. The crop on this rotation was preceded by clover.

In rotation "C" the maximum yield, 283 bushels per acre, was produced under a total depth received of 1·61 feet, of which 0·61 foot was rainfall. The crop on this rotation was preceded by grass. In both rotations the yields increased with the increase in the depth applied up to the maximum, excepting plots 86-A and 86-B in rotation "C".

Summarizing the results of the two potato series, it is shown that the maximum yields were produced under an average depth received of 1·65 feet, of which 0·65 foot was rainfall.

Alfalfa Hay.—In rotation " A ", 1919 seeding, the maximum yield, 5·57 tons per acre, was produced under a total depth received of 3·92 feet. The non-irrigated plot produced 0·05 ton per acre.

In rotation " A ", 1920 seeding, the maximum yield, 5·73 tons per acre, was produced under a total depth received of 2·42 feet. The non-irrigated plot produced 0·42 ton per acre.

In rotation " B ", 1920 seeding, the maximum yield 5·50 tons per acre, was produced under a total depth received of 3·42 feet. The non-irrigated plot produced 0·10 ton per acre.

Summarizing the results of the three alfalfa series, the maximum yields were produced under an average depth received of 3·25 feet. The average maximum yield is 5·60 tons. The average depth used in producing this yield is 2·93 feet.

Grass Hay.—The maximum yield of grass hay, 1·87 tons (3,750 pounds) per acre, was produced under a total depth received of 1·82 feet, of which 0·32 foot was rainfall. The dry plot produced one ton per acre.

Golden Bantam Sweet Corn.—The maximum yield of sweet corn, 21·50 tons green weight per acre, was produced under a total depth received of 1·07 feet, of which 0·57 foot was rainfall. The dry plot produced 7·95 tons per acre.

Dry Land Wheat.—No yield whatever was produced where wheat was grown on non-irrigated land.

WHEAT (MARQUIS), 1921

Rotation E

Plot No.	Area	Irrigation — Date and Depth Applied in Acre-feet per Acre: June 4	June 10	June	June 17	June 24	June 30	July 2	July 7	July	July 18	July	Aug. 26	Aug. 2	Duty of Water	Rainfall April 1 to Harvest	Total Depth Rec'd	Total Depth Used in Growing Crop	Yield per acre	Remarks
															Ft.	Ft.	Ft.	Ft.	Bush.	
30A															0·00	0·42	0·42		0·00	No grain, some straw.
26	0·198				33										0·33	0·42	0·75	0·90	12·3	Cut Aug. 17
25	0·230					33					34				0·67	0·42	1·09	0·98	21·2	" 15
24	0·230				33				34				33		1·00	0·42	1·42	1·35	29·6	" 15
23	0·108		33					34			33			34	1·33	0·42	1·75	1·68	33·3	" 15
27	0·240	33				34			33				34	33	1·67	0·42	2·09	1·80	35·6	" 17
21	0·083	33			34			33			34		33	34	2·00	0·42	2·42	2·08	35·0	" 15
30	0·164					50					50				1·00	0·42	1·42	1·76	29·1	" 15
29	0·193				50					50			50		1·50	0·42	1·92	1·97	42·5	" 15
28	0·222		50					50			50			50	2·00	0·42	2·42	2·02	38·5	" 15

Rotation B

Plot No.	Area	June 4	June 8	June	June 15	June 22	June	July 2	July 6	July	July 16	July 21	July 27	Aug. 2	Duty of Water	Rainfall April 1 to Harvest	Total Depth Rec'd	Total Depth Used in Growing Crop	Yield per acre	Remarks
68A															0·00	0·42	0·42	0·72	0·00	No grain, some straw.
68B	0·0344				33										0·33	0·42	0·75	1·02	23·8	Cut Aug. 15
68C	0·0339					33					34				0·67	0·42	1·09	1·10	18·1	" 15
68D	0·0333				33				34			33			1·00	0·42	1·42	1·25	25·6	" 15
68E	0·0343		33					34			33		34		1·33	0·42	1·75	1·44	32·4	" 15
69A	0·0340	33				34			33			34		33	1·67	0·42	2·09	1·79	38·4	" 15
69B	0·0343	33			34			33			34		33	34	2·00	0·42	2·42	2·50	38·7	" 15
69C	0·0345					50					50				1·00	0·42	1·42	1·94	29·4	" 15
69D	0·0339				50				50			50			1·50	0·42	1·92	2·07	30·4	" 15
69E	0·0346		50					50			50		50		2·00	0·42	2·42	2·38	39·0	" 15

Rotation C

			3	9	15	21	30		6		15	21	27	2						
94A															0·00	0·42	0·42	0·68	0·00	Cut Aug. 8–17
94B	0·0405				33										0·33	0·42	0·75	0·85	3·38	" 8–17
94C	0·0458					33					34				0·67	0·42	1·09	1·03	13·40	" 8–17
94D	0·0544				33				34			33			1·00	0·42	1·42	1·51	23·82	" 8–17
94E	0·0578			33			34				33		34		1·33	0·42	1·75	2·03	29·0	" 8–17
93A	0·0710		33			34			33			34		33	1·67	0·42	2·09	2·19	34·9	" 8–17
93B	0·0528		33		34		33				34		33	34	2·00	0·42	2·42	2·40	33·6	" 8–17
93C	0·0625					50					50				1·00	0·42	1·42	1·55	29·2	" 8–17
93D	0·0304				50				50			50			1·50	0·42	1·92	2·17	34·0	" 8–17
93E	0·0243			50			50				50		50		2·00	0·42	2·42	2·01	31·5	" 8–17

IRRIGATION EXPERIMENT STATION, BROOKS, ALBERTA. | PLOT SERIES RECORD

OATS (BANNER), 1921

ROTATION D

Plot No.	Area	Irrigation — Date and Depth Applied in Acre-feet per Acre													Duty of Water	Rain-fall April 1 to Har-vest	Total Depth Rec'd	Total Depth Used in Grow-ing Crop	Yield per acre	Remarks
		June						July					Aug.							
		4	8		16	22	30		7		16	23	27	2						
															Ft.	Ft.	Ft.	Ft.	Bush.	
76A															0·00	0·42	0·42	0·68	0·00	Cut Aug. 16
76B	0·0343				33										0·33	0·42	0·75	1·37	112·0	" 16
76C	0·0337					33					34				0·67	0·42	1·09	1·63	113·0	" 16
76D	0·0343				33				34			33			1·00	0·42	1·42	1·70	131·5	" 16
76E	0·0339		33				34				33		34		1·33	0·42	1·75	1·74	135·0	" 16
77A	0·0331	33				34			33			34		33	1·67	0·42	2·09	1·71	143·0	" 16
77B	0·0336	33			34		33				34		33	34	2·00	0·42	2·42	1·99	131·0	" 16
77C	0·0331					50					50				1·00	0·42	1·42	1·57	118·1	" 15
77D	0·0348				50				50			50			1·50	0·42	1·92	1·96	113·0	" 16
77E	0·0305		50				50				50		50		2·00	0·42	2·42	2·62	117·0	" 16

ROTATION B (a)

		4	9		16	22	30		6		16	22	27	2						
70A															0·00	0·42	0·42	0·55	0·00	Cut Aug. 16
70B	0·0233				33										0·33	0·42	0·75	0·83	39·4	" 16
70C	0·0230					33					34				0·67	0·42	1·09	1·64	112·0	" 16
70D	0·0229				33				34			33			1·00	0·42	1·42	1·78	133·4	" 16
70E	0·0217		33				34				33		34		1·33	0·42	1·75	1·85	128·0	" 16
71A	0·0358	33				34			33			34		33	1·67	0·42	2·09	2·00	116·0	" 16
71B	0·0346	33			34		33				34		33	34	2·00	0·42	2·42	2·36	127·0	" 16
71C	0·0342					50					50				1·00	0·42	1·42	1·55	134·0	" 16
71D	0·0345				50				50			50			1·50	0·42	1·92	1·96	138·1	" 16
71E	0·0328		50				50				50		50		2·00	0·42	2·42	2·68	135·8	" 16

Rotation E

		3	10		17	22		4	8		18	24	28	3						
32															0·00	0·39	0·39	0·45	0·00	Cut Aug. 8
31	0·0262		11			22									0·33	0·39	0·72	0·83	38·4	" 9
36	0·224					33					34				0·67	0·39	1·06	1·03	67·0	" 9
37	0·225				33				34			33			1·00	0·39	1·39	1·32	68·1	" 9
38	0·227		33					34			33		34		1·33	0·39	1·72	1·62	62·4	" 9
39–32A	0·424	33				34			33			34		33	1·67	0·39	2·06	1·92	80·0	" 9
40	0·229	33			34			33			34		33	34	2·00	0·39	2·39	2·15	91·2	" 9
33	0·0605					50					50				1·00	0·39	1·39	1·13	63·0	" 9
34	0·0644				50				50			50			1·50	0·39	1·89	1·61	66·0	" 9
35	0·0634		50					50			50		50		2·00	0·39	2·39	1·72	66·8	" 9

Rotation B (b)

		3	7		16	21		2	6		16	21	27	2						
66A															0·00	0·39	0·39	0·00	0·00	Cut Aug. 8
66B	0·0246				33										0·33	0·39	0·72	0·96	43·4	" 8
66C	0·0253					33					34				0·67	0·39	1·06	1·11	54·0	" 8
66D	0·0247				33				34			33			1·00	0·39	1·39	1·35	62·1	" 8
66E	0·0251		33					34			33		34		1·33	0·39	1·72	1·55	73·2	" 8
67A	0·0420	33				34			33			34		33	1·67	0·39	2·06	2·10	84·7	" 8
67B	0·0310	33			34						34		33	34	2·00	0·39	2·39	2·08	74·0	" 8
67C	0·0309					50					50				1·00	0·39	1·39	1·32	60·0	" 8
67D	0·0306				50				50			50			1·50	0·39	1·89	1·91	59·0	Patchy, cut Aug. 8
67E	0·0322		50					50			50		50		2·00	0·39	2·39	2·15	70·0	" 8

BARLEY (O.A.C. 21), 1921

ROTATION E

Plot No.	Area	Irrigation — Date and Depth Applied in Acre-feet per Acre: June						July					Aug.		Duty of Water	Rain-fall April 1 to Har-vest	Total Depth Rec'd	Total Depth Used in Grow-ing Crop	Yield per acre	Remarks
			7	10	16	25		4	8		18	26	29							
															Ft.	Ft.	Ft.	Ft.	Bush.	
7B	0·107				20										0·00	0·35	0·35	0·60	12·1	Cut Aug. 2
6	0·236				33										0·33	0·35	0·68	0·84	24·0	" 2
5	0·235					33					34				0·67	0·35	1·02	1·10	18·8	" 2
4	0·233				33				34			33			1·00	0·35	1·35	1·37	37·4	" 2
3	0·234			33				34			33		34		1·34	0·35	1·69	1·52	42·6	" 2
2-7A	0·359		33			34			33			34			1·34	0·35	1·69	1·65	49·2	" 2
1	0·237		33		34			33			34	33			1·67	0·35	2·02	1·40	39·2	Subject to see page.
10	0·237					50					50				1·00	0·35	1·35	1·53	21·4	" 2
9	0·237				50				50			50			1·50	0·35	1·85	1·91	40·1	" 2
8	0·234			50				50			50		50		2·00	0·35	2·35	2·33	44·2	" 2
ROTATION D																				
		4	9		16	22		2	7		16	22	27							
74A															0·00	0·35	0·35	0·27	00·0	No yield
74B	0·030				33										0·33	0·35	0·68	0·87	34·7	Cut Aug. 3
74C	0·0312					33					34				0·67	0·35	1·02	1·07	42·1	" 3
74D	0·0293				33				34			33			1·00	0·35	1·35	1·17	58·6	" 3
74E	0·032		33					34			33		34		1·34	0·35	1·69	1·53	47·8	" 3
75A	0·0325	33				33			34			33			1·34	0·35	1·69	1·70	60·5	" 3
75B	0·0310	33			34			33			34		33		1·67	0·35	2·02	1·98	60·5	" 3
75C	0·032					50					50				1·00	0·35	1·35	0·97	51·2	" 3
75D	0·030				50				50			50			1·50	0·35	1·85	1·65	52·0	" 3
75E	0·0317		50					50			50		50		2·00	0·35	2·35	2·20	52·5	" 3
ROTATION C																				
		3		13	15	21	30		6		15	21	27							
83A	0·032														0·00	0·35	0·35	0·67	0·00	
83B	0·034				33										0·33	0·35	0·68	1·27	10·0	Cut Aug. 3
83C	0·034					33					34				0·67	0·35	1·02	1·32	23·7	" 3
83D	0·033				33				34			33			1·00	0·35	1·35	1·40	47·0	" 3
83E	0·033			33			34				33		34		1·34	0·35	1·69	1·46	52·0	" 3
84A	0·023	33				34			33			34			1·34	0·35	1·69	1·40	52·0	" 3
84B	0·0338	33			34		33				34	33			1·67	0·35	2·02	1·39	44·5	" 3
84C	0·0338					50					50				1·00	0·35	1·35	1·44	38·5	" 3
84D	0·0336				50				50			50			1·50	0·35	1·85	1·47	27·5	" 3
84E	0·0330			50			50				50		50		2·00	0·35	2·35	1·93	21·6	" 3

PLOT SERIES RECORD

ALFALFA SEED (GRIMM), 1921

Plot No.	Area	Irrigation — Date and Depth Applied in Acre-feet per Acre						Duty of Water	Rainfall April 1 to Harvest	Total Depth Rec'd	Total Depth Used in Growing Crop	Yield per acre	Remarks		
		—		June		July	Aug.								
	D	R	H	7	22	11	2					D	R	H	
								Ft.	Ft.	Ft.	Ft.	Bush.	Bu.	Bu.	Cut
41A								0·00	0·57	0·57	0·54	0·0	0·0	0·0	9-16
B				25				0·25	0·57	0·82	0·79	0·0	0·0	0·0	9-16
C	0·0095	0·0170	0·0062	25		25		0·50	0·57	1·07	1·06	0·88	1·87	1·4	9-16
D	0·0096	0·0122	0·0074	25		25	25	0·75	0·57	1·32	1·21	1·85	1·54	1·12	9-16
E	0·0052	0·0083	0·0045	25	25	25	25	1·00	0·57	1·57	1·48	3·20	2·38	3·7	9-16

Rainfall.—To April 30th, 0·95 in.; to May 31st 1·55 in.; to June 30th, 21 in.; to July 31st 1·44 in.; to Aug. 31st, 1·46 in.; to Sept. 30th, 2·65 in.

NOTE.—In the case of yield per acre "D" equals drills, "R" rows, and "H" hills. The yields shown are total yields obtained and do not represent per cent of visible seed.

PEAS (PRUSSIAN BLUE) 1921

ROTATION E

PLOT SERIES RECORD

Plot No.	Area	Irrigation — Date and depth applied in acre-feet per acre														Duty of Water	Rainfall April 1 to Harvest	Total Depth Rec'd	Total Depth Used in Growing	Yield per Acre	Remarks
		June					July						August								
		3	10	13	18	24	4	9	11	20	25	29	2	6	10					Crop	
																Ft.	Ft.	Ft.	Ft.	Bush.	
14B	0·125															0·00	0·47	0·47	0·72	0·00	No yield.
15	0·229				33											0·33	0·47	0·80	0·88	8·25	Cut Aug. 18
16	0·232					33				34						0·67	0·47	1·14	1·21	28·3	" " 25
17	0·234				33			34			33					1·00	0·47	1·47	1·87	52·5	" " 26 patch
18	0·229		33				34			33		34				1·34	0·47	1·81	1·88	52·0	" " 26
19-14A	0·358	33				34		33			34		33			1·67	0·47	2·14	2·44	51·1	" " 28
20A	0·0984	33			34		33			34		33		34		2·00	0·47	2·47	2·74	60·3	" " 26
11	0·228					50				50						1·00	0·47	1·47	2·01	44·3	" " 26
12	0·230				50			50			50					1·50	0·47	1·97	2·22	56·7	" " 26
13	0·236	..	50				50			50		50				2·00	0·47	2·47	2·37	56·0	" " 26
20B	0·0493	33		34	33		33		34		33		34			2·34	0·47	2·81	2·86	58·4	
20C	0·0467	33		34	33		33		34		33		34		33	2·67	0·47	3·14	2·68	57·2	

POTATOES (GOLD COIN), 1921

Rotation A

Plot No.	Area	Irrigation — Date and Depth applied in Acre-feet per Acre: June		July					August					Duty of Water	Rainfall April 1 to Harvest	Total Depth Rec'd	Total Depth Used in Growing Crop	Yield per Acre	Remarks
		—	26	7	12	18	21	28	5	10	15	25	30						
														Ft.	Ft.	Ft.		Bush.	
54-A	0·0242	......	......	......	......	......	......	......	......	......	......	......	......	0·00	0·69	0·69	....	120·0	34·5 p.c. small
B	0·0364	......	17	......	......	......	......	......	......	......	......	......	......	0·17	0·69	0·86	....	166·0	24·5 " "
C	0·0364	......	17	......	......	......	......	17	......	......	......	......	......	0·33	0·69	1·02	....	211·0	17·8 " "
D	0·0364	......	17	......	......	......	17	......	......	......	16	......	......	0·50	0·69	1·19	....	245·0	12·6 " "
E	0·0364	......	17	......	......	17	......	......	16	......	......	17	......	0·67	0·69	1·36	....	301·0	10·0 " "
55-A	0·0485	......	17	......	17	......	......	16	......	17	......	17	......	0·83	0·69	1·52	....	340·0	10·2 " "
B	0·0485	......	17	17	......	16	......	......	17	......	16	......	17	1·00	0·69	1·69	....	388·0	8·6 " "
C	0·0485	......	25	......	......	......	......	25	......	......	......	......	......	0·50	0·69	1·19	....	298·0	8·6 " "
D	0·0485	......	25	......	......	......	25	......	......	......	25	......	......	0·75	0·69	1·44	....	379·0	7·0 " "
E	0·0364	......	25	......	......	25	......	......	25	......	......	25	......	1·00	0·69	1·69	....	421·0	5·2 " "

Rotation C

Plot No.	Area	25	—	7	11	16	21	28	5	10	15	25	30	Duty of Water	Rainfall April 1 to Harvest	Total Depth Rec'd	Total Depth Used in Growing Crop	Yield per Acre	Remarks
85-A	0·0118	17	......	......	......	......	......	......	......	......	......	......	......	0·17	0·61	0·78	....	141·0	21·0 " "
B	0·0240	17	......	......	......	......	......	......	......	......	......	......	......	0·17	0·61	0·78	....	135·0	22·0 " "
C	0·0358	17	......	......	......	......	......	16	......	......	......	......	......	0·33	0·61	0·94	....	170·0	13·2 " "
D	0·0476	17	......	......	......	......	16	......	......	......	17	......	......	0·50	0·61	1·11	....	214·0	9·8 " "
E	0·0358	17	......	......	......	16	......	......	17	......	......	16	......	0·67	0·61	1·28	....	263·0	6·7 " "
86-A	0·0340	17	......	......	17	......	......	16	......	17	......	16	......	0·83	0·61	1·44	....	262·0	10·3 " "
B	0·0330	17	......	17	......	16	......	......	17	......	16	......	17	1·00	0·61	1·61	....	227·0	15·0 " "
C	0·0320	25	......	......	......	......	......	25	......	......	......	......	......	0·50	0·61	1·11	....	221·0	16·2 " "
D	0·0310	25	......	......	......	......	25	......	......	......	25	......	......	0·75	0·61	1·36	....	252·0	9·6 " "
E	0·0200	25	......	......	......	25	......	......	25	......	......	25	......	1·00	0·61	1·61	....	283·0	8·8 " "

ALFALFA (GRIMM (LYMAN'S)), 1921

Rotation A Seeded 1919

Plot No.	Area	Irrigation — Date and Depth applied in Acre-feet per Acre											Duty of Water	Rainfall April 1 to Harvest	Total Depth Rec'd	Total Depth Used in Growing Crop	Yield per Acre	Remarks
		June					July			August								
		6	13	16	22	25	11	18	27	2	5	15						
													Ft.	Ft.	Ft.	Ft.	Tons	
44A	0·0065												0·00	0·23	0·23	0·40	0·05	Cut 6–30
B	0·0194		33										0·33	0·23	0·56	0·73	0·978	" 6–30 8–17
C	0·0246	33					34						0·67	0·42	1·09	1·04	1·62	" 6–30 8–17
D	0·0252	33				34		33					1·00	0·42	1·42	1·52	1·43	" 6–30 8–17
E	0·0266	33			33		34			33			1·33	0·42	1·75	1·79	2·71	" 6–30 8–17
45A	0·0663	33			34		33			33		34	1·67	0·42	2·09	1·80	4·60	" 6–30 8–17
B	0·0278	33		33			33	33		33		34	2·00	0·42	2·42	2·03	5·24	" 6–30 8–17
C	0·0288	50			50		50			50		50	2·50	0·42	2·92	2·07	4·44	" 6–30 8–17
D	0·0304	50		50			50	50		50		50	3·00	0·42	3·42	2·87	5·55	" 6–30 8–17
E	0·0317	50		50			50	50	50		50	50	3·50	0·42	3·92	3·83	5·57	" 6–30 8–17

ALFALFA (GRIMM'S (LYMAN'S)), 1921

ROTATION A SEEDED 1920

Plot No.	Area	Irrigation — Date and Depth Applied in Acre-feet per Acre: June 6	June 13	June 15	June 28	July 2	July 11	July 16	July 27	Aug. 1	Aug. 6	Aug. 16		Duty of Water	Rainfall April 1 to Harvest	Total Depth Rec'd	Total Depth Used in Growing Crop	Yield per acre	Remarks
														Ft.	Ft.	Ft.	Ft.	Tons	
46A	0·009)													0·00	0·23	0·23	1·01	0·417	
46B	0·0236		33											0·33	0·23	0·56	1·26	0·89	
46C	0·0283	33					34							0·67	0·42	1·09	1·31	2·25	
46D	0·0302	33				33		34						1·00	0·42	1·42	1·64	3·77	
46E	0·0297	33			33		33			34				1·33	0·42	1·75	2·15	4·17	
47A	0·0309	33			33		33			34		34		1·67	0·42	2·09	2·24	4·49	
47B	0·0308	33		33			33	33		34		34		2·00	0·42	2·42	1·94	5·73	
47C	0·0331	50			50		50			50		50		2·50	0·42	2·92	2·69	5·22	
47D	0·0306	50		50			50	50		50		50		3·00	0·42	3·42	3·23	5·72	
47E	0·0310	50		50			50	50	50		50	50		3·50	0·42	3·92	3·39	5·12	

ROTATION B SEEDED 1920

Plot No.	Area	June 6	June 13	June 15	June 21	July 2	July 11	July 16	July 27	Aug. 2	Aug. 6	Aug. 15		Duty of Water	Rainfall April 1 to Harvest	Total Depth Rec'd	Total Depth Used in Growing Crop	Yield per acre	Remarks
														Ft.	Ft.	Ft.	Ft.	Tons	
62A	0·0030													0·00	0·23	0·23		0·10	Cut 6–30
62B	0·0338		33											0·33	0·23	0·56		0·80	"
																			1st 2nd
62C	0·0333	33					34							0·67	0·42	1·09		1·075	" 8–18
62D	0·0324	33				33		34						1·00	0·42	1·42		1·735	" "8–18
62E	0·0320	33			33		33			33				1·33	0·42	1·75		2·80	" "8–18
63A	0·0337	33			33		33			33		34		1·67	0·42	2·09		5·16	" "8–18
63B	0·0332	33		33			33	33		33		34		2·00	0·42	2·42		5·165	" "8–18
63C	0·0337	50			50		50			50		50		2·50	0·42	2·92		4·515	" "8–18
63D	0·0335	50		50			50	50		50		50		3·00	0·42	3·42		5·50	" "8–18
63E	0·0333	50		50			50	50	50		50	50		3·50	0·42	3·92		5·30	" "8–18

GRASS (MIXED), 1921

ROTATION C

		2	15	21	28	1	6	15	25									
														Ft.	Ft.	Ft.	Ft.	Lbs.	
87-90A	0·032	....	....	....	....	....	....	....	....	....	....	....	....	0·00	0·32	0·32	0·57	2,000	Cut July 19
87-90B	0·106	33	....	....	....	....	....	....	....	....	....	....	....	0·33	0·32	0·65	0·94	2,961	" 19
87-90C	0·084	33	....	34	....	....	....	....	....	....	....	....	....	0·67	0·32	0·99	1·24	2,930	" 19
87-90D	0·061	33	34	....	....	33	....	....	....	....	....	....	....	1·00	0·32	1·32	....	2,590	" 19
87-90E	0·052	33	34	....	....	33	....	(34)	....	....	....	....	(34)	1·00	0·32	1·32	1·48	2,460	" 19
87-90F	0·068	33	34	....	33	....	34	(33)	....	....	....	....	(33)	1·33	0·32	1·65	1·66	2,850	" 19
87-90G	0·063	33	34	....	33	....	34	(33)	(34)	....	....	....	(67)	1·33	0·32	1·65	1·45	2,960	" 19
87-90H	0·084	50	....	50	....	....	....	....	....	....	....	....	....	1·00	0·32	1·32	1·20	3,290	" 19
87-90K	0·077	50	50	....	....	50	....	....	....	....	....	....	....	1·50	0·32	1·82	1·30	3,612	" 19
87-90L	0·087	50	50	....	....	50	....	(50)	....	....	....	....	(50)	1·50	0·32	1·82	1·46	3,750	" 19

CORN (GOLDEN BANTAM), 1921

ROTATION B

Plot No.	Area	Irrigation — Date and Depth Applied in Acre-feet per Acre												Duty of Water	Rain-fall April 1 to Har-vest	Total Depth Rec'd	Total Depth Used in Grow-ing crop	Yield per acre	Yield of Roasting ears per plot of 0·025 acre
		June					July					Aug.							
		9	13	16	22	25	2	7	16	22	27	2	6						
														Ft.	Ft.	Ft.	Ft.	Tons	
73A	0·025	....	....	....	....	....	....	....	....	....	....	....	....	0·00	0·57	0·57	0·66	7·95	21·0 doz. Cut Sept. 14
73B	0·025	....	....	....	....	17	....	....	....	....	....	....	....	0·17	0·57	0·74	0·84	12·00	28 doz. Cut Sept 14
73C	0·025	....	....	....	17	....	....	....	16	....	....	....	....	0·33	0·57	0·90	1·13	16·30	26·4 doz. Cut Sept. 14
73D	0·025	....	....	17	....	....	....	16	....	17	....	....	....	0·50	0·57	1·07	1·36	21·50	60 doz. Cut Sept. 14
73E	0·025	....	17	....	....	....	16	....	17	....	16	....	....	0·67	0·57	1·24	1·47	20·03	48·5 doz. Cut Sept. 14
3F	0·025	17	....	....	16	....	....	17	....	16	....	17	....	0·84	0·57	1·41	1·50	20·00	48·5 doz. Cut Sept. 14
73G	0·023	17	....	16	....	....	17	....	16	....	17	....	16	1·00	0·57	1·57	1·52	16·77	37·0 doz. Cut Sept. 14

DUTY OF WATER INVESTIGATION AT VAUXHALL

Duty of water investigations were commenced in the spring of 1921 on the Kinlock farm of the Canada Land & Irrigation Company near Vauxhall.

The work at Ronalane was abandoned in favour of the Vauxhall location, as the latter farm is situated in the most thickly settled and best farmed area of the Canada Land & Irrigation Company's tract where the results obtained from the irrigation investigations can be observed by a large number of resident farmers. The Kinlock farm has a more uniform soil than the Ronalane farm and is better adapted for experimental work.

The accompanying plan shows the general layout of the plots at Kinlock farm. The failure of the company's local representative to apply the irrigations according to the arranged schedule makes the data obtained more or less unsatisfactory, as we do not know whether additional irrigations would have increased or decreased the yield, or what influence the irrigations would have had if they had been applied at the right time.

Canada Blue Peas.—The maximum yield, 24·4 bushels per acre was produced under a total depth received of 1·39 feet, of which 0·99 foot was received in three 4-inch irrigations.

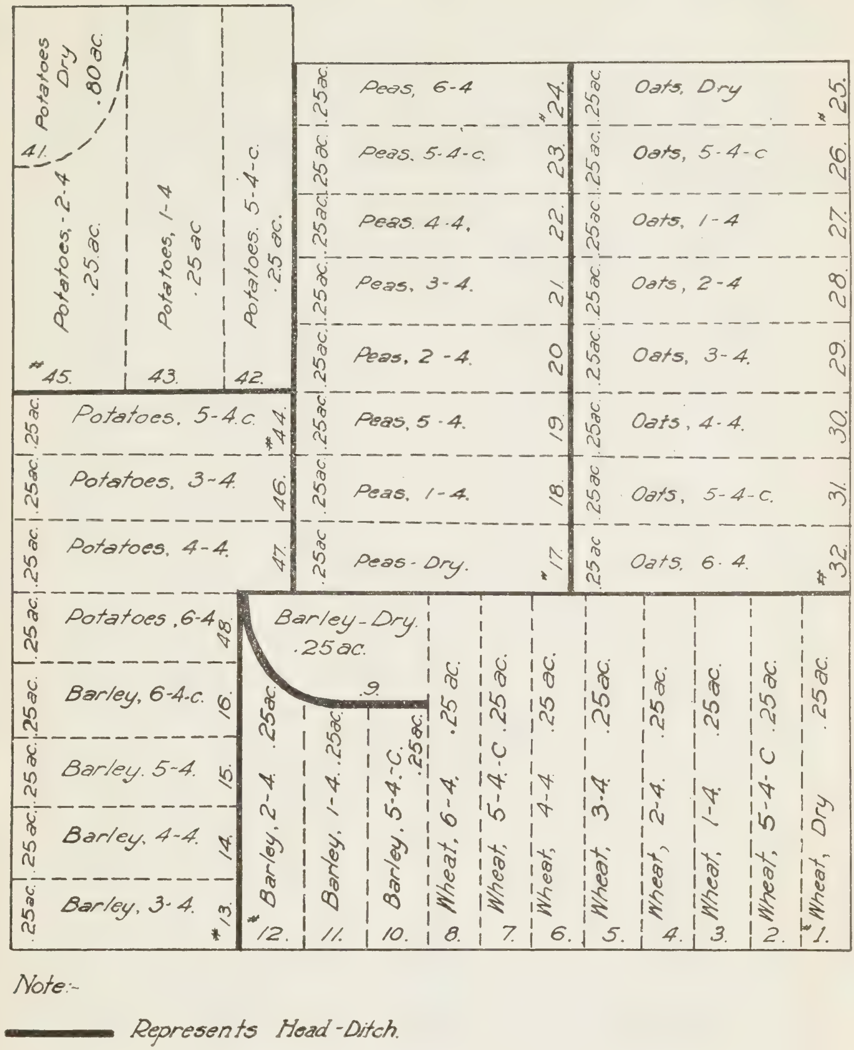
Marquis Wheat.—The maximum yield, 43·2 bushels per acre, was produced under a total depth received of 1·71 feet, of which 1·32 feet were received in four 4-inch irrigations.

Leader Oats.—The maximum yield, 116·4 bushels per acre, was produced under a total depth received of 1·72 feet, of which 1·32 feet were received in four 4-inch irrigations.

Bark's Barley.—The maximum yield, 47·6 bushels per acre was produced under a total depth received of 1·71 feet, of which 1·32 feet were received in four 4-inch irrigations.

Gold Coin Potatoes.—The maximum yield, 376 bushels per acre, was produced under a total depth received of 1·82 feet, of which 1·25 feet were received in five 3-inch irrigations.

Grimm's Alfalfa (Ronalane).—The maximum yield, 3·28 tons per acre, was produced under a total depth received of 2·39 feet, of which 2 feet were received in four 6-inch irrigations.



Department of the Interior,
RECLAMATION SERVICE.
IRRIGATION DIVISION
CALGARY

~Diagram of Test Plots at
~Kinlock Farm~
1921

Irrigation Experiment Plots, Vauxhall, Alberta—Plot Series Record

Canada Land and Irrigation Co., Ltd., Kinlock, Farm

PEAS (CANADIAN BLUE), 1921

Plot No.	Area	Irrigation — Date and Depth applied in Acre-feet per Acre: June	June 17	June 25	July 5	July 16	July 22	July 28	Aug. 2	Duty of Water	Rainfall April 1 to Harvest	Total Depth Rec'd	Total Depth Used in Growing crop	Yield per acre	Remarks
										Ft.	Ft.	Ft.	Ft.	Bush.	
17	0·25										0·40	0·40		6·8	
19	0·25			33						0·33	0·40	0·73		12·4	
20	0·25			33					33	0·66	0·40	1·06		15·6	
21	0·25		33			33				0·66	0·40	1·06		23·2	
22	0·25		33				33			0·66	0·40	1·06		20·8	
23	0·25		33		33				33	0·99	0·40	1·39		24·4	
18	0·25		33		33				33	0·99	0·40	1·39		21·6	
24	0·25		33		33			33		0·99	0·40	1·39		24·0	

Remarks—17-24.—Cropped to grain 1918, manured 1921.
Cropped to potatoes 1919, spring ploughed 7″. Cropped to barley 1920, seeded 2½″ per acre grain drill.
Cropped to peas 1921, harvested Aug. 10. Ripened before all scheduled irrigations could be applied.

WHEAT (MARQUIS), 1921

Plot No.	Area	11	17	26	2	5	12	22	2	Duty of Water	Rainfall April 1 to Harvest	Total Depth Rec'd	Total Depth Used in Growing crop	Yield per acre	Remarks
										Ft.	Ft.	Ft.	Ft.	Bush.	
1	0·25									0·00	0·39	0·39		8·4	Estimated.
3	0·25		33							0·33	0·39	0·72		24·8	
4	0·25		33					33		0·66	0·39	1·05		33·2	
5	0·25		33		33			33		0·99	0·39	1·38		37·6	
6	0·25		33			33		33	33	1·32	0·39	1·71		40·0	
2	0·25	33		33				33	33	1·32	0·39	1·71		43·2	Less sloping than No. 7.
7	0·25	33		33				33	33	1·32	0·39	1·71		40·4	More sloping than No. 2.
8	0·25	33		33			33		33	1·32	0·39	1·71		39·2	

Remarks—Plots 1-8.—Cropped to grain 1918. Seeded April 30, 2 bush. Cropped potatoes 1919. Harvested Aug. 8.
Cropped to barley 1920. Ploughed spring 7″.

Irrigation Experiment Plots, Vauxhall, Alberta—Plot Series Record

Canada Land and Irrigation Co., Ltd., Kinlock Farm

OATS (LEADER), 1921

Plot No.	Area	Irrigation — Date and Depth applied in Acre-feet per Acre: June 11	June 17	June 26	July 2	July 5	July 12	July 22	Aug. 2	Duty of Water	Rain-fall April 1 to Harvest	Total Depth Rec'd	Total Depth Used in Grow-ing Crop	Yield per acre	Remarks
										Ft.	Ft.	Ft.	Ft.	Bush.	
25	0·25	......	......	......	......	......	......	......	......	0·00	0·40	0·40	......	12·4	
27	0·25	......	33	......	......	......	......	......	......	0·33	0·40	0·73	......	66·4	
28	0·25	......	33	......	......	......	......	33	......	0·66	0·40	1·06	......	80·4	
29	0·25	......	33	......	33	......	......	33	......	0·99	0·40	1·39	......	109·6	
30	0·25	......	33	......	......	33	......	33	33	1·32	0·40	1·72	......	112·8	
31	0·25	33	......	33	......	......	......	33	33	1·32	0·40	1·72	......	116·4	
26	0·25	33	......	33	......	......	......	33	33	1·32	0·40	1·72	......	115·6	
										(1·32)		(1·72)			
32	0·25	33	......	33	......	......	33	......	......	0·99	0·40	1·39	......	112·0	

Remarks.—25–32 Cropped to grain 1918. Harvested Aug. 8. Cropped to potatoes 1919, Cropped to barley 1920. Grain matured before irrigations completed. Spring ploughed 7". Seeded April 27, 2½ bush.

BARLEY (BARK'S), 1921

		11	17	26	2	5	12	22	2				Crop		
9	0·25	......	......	......	......	......	......	......	......	0·00	0·39	0·39	......	3·2	
10	0·25	33	......	33	......	......	......	33	33	1·32	0·39	1·71	......	43·2	
11	0·25	......	33	......	......	......	......	......	......	0·33	0·39	0·72	......	16·4	
12	0·25	......	33	......	......	......	......	33	......	0·66	0·39	1·05	......	25·2	
13	0·25	......	33	......	33	......	......	33	......	0·99	0·39	1·38	......	32·8	
14	0·25	......	33	......	......	33	......	33	33	1·32	0·39	1·71	......	40·0	
15	0·25	33	......	33	......	......	......	33	33	1·32	0·39	1·71	......	44·4	
16	0·25	33	......	33	......	......	33	......	33	1·32	0·39	1·71	......	47·6	

Irrigation Experiment Plots, Vauxhall, Alberta—Plot Series Record
Canada Land and Irrigation Co., Ltd., Kinlock Farm
POTATOES (GOLD COIN), 1921

Plot No.	Area	Irrigation — Date and Depth applied in Acre-feet per Acre												Duty of Water	Rain-fall April 1 to Harvest	Total Depth Rec'd	Total Depth Used in Grow-ing crop	Yield per acre	Remarks
		June				July				Aug.									
		17		25		5	16	22	28	2	6	18	30						
														Ft.	Ft.	Ft.	Ft.	Bush.	
41	0·80	....	....	....	....	....	....	....	....	....	....	....	....	0·00	0·567	0·567	....	46·5	
43	0·25	....	....	25	....	....	....	....	....	....	....	....	....	0·25	0·567	0·817	....	124·8	
44	0·25	....	....	25	....	....	....	25	....	....	....	....	....	0·50	0·567	1·067	....	191·2	
45	0·25	....	....	25	....	....	25	....	....	25	....	....	....	0·75	0·567	1·317	....	217·2	
46	0·25	25	....	25	....	....	25	....	25	....	....	....	....	1·00	0·567	1·567	....	280·0	
47	0·25	....	....	25	25	....	....	25	....	25	....	25	....	1·25	0·567	1·817	....	352·0	
42	0·25	....	....	25	25	....	....	25	....	25	....	25	....	1·25	0·567	1·817	....	376·0	
48	0·25	....	....	25	25	....	....	25	....	....	25	25	25	1·50	0·567	2·067	....	320·4	

NOTES.—Cropped to grain, 1918.   Manured in 1921.
Cropped to potatoes, 1919.   Seeded May 18, 18 bush per acre.
Cropped to barley, 1920.   Harvested Oct. 1.
Cropped to potatoes, 1921.

Irrigation Experiment Station, Ronalane, Alberta—Plot Series Record
By Canada Land and Irrigation Co., Ltd., Ronalane Farm
ALFALFA (GRIMM'S SEEDED 1916), 1921

Plot No.	Area	Irrigation — Date and Depth applied in Acre-feet per Acre												Duty of Water	Rain-fall April 1 to Harvest	Total Depth Rec'd	Total Depth Used in Grow-ing crop	Yield per acre	Remarks
		May	June			July				Aug.									
		25	6	9	16	12	16	22	28		11	18							
														Ft.	Ft.	Ft.	Ft.	Tons	
1	0·25	....	....	....	....	....	....	....	....	....	....	....	....	0·00	0·39	0·39	....	0·400	
2	0·25	....	....	....	....	33	....	....	....	....	....	....	....	0·33	0·39	0·72	....	0·740	
3	0·25	....	....	33	....	33	....	....	....	....	33	....	....	0·99	0·39	1·38	....	1·760	
4	0·25	....	....	33	....	33	....	....	33	....	33	....	....	1·32	0·39	1·71	....	2·664	
5	0·25	....	33	....	....	33	....	....	33	....	33	33	....	1·65	0·39	2·04	....	2·788	
6	0·25	33	....	....	33	33	33	....	....	....	33	33	....	1·98	0·39	2·37	....	3·000	
7	0·25	33	....	33	....	33	33	33	33	....	33	33	....	2·64	0·39	3·03	....	3·220	
8	0·25	....	....	50	....	50	....	....	....	....	50	50	....	2·00	0·39	2·39	....	3·280	
9	0·25	....	....	50	....	50	....	....	....	....	50	50	....	2·00	0·39	2·39	....	3,272	
10	0·25	....	....	50	....	50	50	....	50	....	50	50	....	3·00	0·39	3·39	....	3,104	

NOTE.—Second cutting seemed to be scalded when irrigated.

DUTY OF WATER, COALDALE, ALBERTA

Duty of water investigations at Coaldale were carried on during the season of 1921 by Mr. Wm. Chadwick. The work was commenced on May 9, when soil moisture determinations were made on all the tracts under observation. Water was available to the farmers about the 15th May. Irrigations of alfalfa began towards the end of the month. Light snowfalls and showers were of frequent occurrence during the month, accompanied by strong winds. Eight degrees of frost was registered May 28.

Strong winds occurred during the latter part of June which caused some soil drifting. Considerable damage was done in this month by cutworms on tracts 325, 326 and 327, more than half the crop of wheat on tract 327 being destroyed. The duty of water observations on this tract were therefore abandoned for the season.

Grasshoppers were very numerous during August and caused considerable damage to the grain growing on tract 322.

The table immediately following gives a summary of the duty of water data obtained during the season. All alfalfa fields except No. 302 received two irrigations. No field yielded more than two cuttings. Tract No. 324 produced the heaviest first cutting, 2·84 tons per acre. Plot 305 produced the heaviest total yield, 4·22 tons per acre for the two cuttings, with a total depth received of 2·19 feet.

For the thirteen tracts in forage crops during 1921, the average total depth of water received was 1·94 feet, and for the five tracts in grain crops, the average total depth received was 1·25 feet.

For all tracts the average total depth of water received was 1·75 feet.

DUTY OF WATER TRACTS, COALDALE, ALBERTA, 1921

Plot No.	Acres	Irrigation					Acre-feet per Acre								Yield in Tons		Crop	Remarks
		No.	Began	Ended	Duration in Hours	Average Head C.F.S.	Supplied	Wasted	Used	Used per Acre	Duty	Rainfall April 1 to Harvest	Total Depth Rec'd	Total Depth Used	Per Cutting	Per Acre		
302	30·00	1	June 11	June 16	111	3·71	34·24	4·95	29·29	0·97	0·97	0·44	1·41	1·74	1·13	2·13	Alfalfa	Seeded 1909
															1·00			
304	42·00	1	June 4	June 12	189	2·14	33·58	6·24	27·34	0·65					2·57		Alfalfa	" 1907
		2	July 26	Aug. 8	302	1·59	39·77	6·57	33·20	0·79	1·44	0·45	1·89	1·83	1·37	3·94		
305	22·50	1	June 9	June 16	190	1·60	25·22	6·43	18·79	0·80					2·32		Alfalfa	" 1912
		2	July 22	July 29	165	2·14	29·34	7·22	22·12	0·94	1·74	0·45	2·19	2·25	1·90	4·22		
306	14·00	1	June 5	June 8	74	1·27	7·80	0·61	7·19	0·51					2·69		Alfalfa	" 1914
		2	Aug. 4	Aug. 7	75	2·46	15·29	2·02	13·27	0·95	1·46	0·45	1·91	1·53	1·31	4·00		
310	19·70	1	June 1	June 5	104	1·36	11·70		11·70	0·60					1·89		Alfalfa	" 1914
		2	July 13	July 16	60	3·00	14·88	1·50	13·38	0·68	1·28	0·45	1·73	1·51	0·74	2·63		
312	50·00	1	June 10	June 16	141	2·10	24·49		24·49	0·49					1·92		Alfalfa	" 1914
		2	July 14	July 23	215	2·65	47·47		47·47	0·95	1·44	0·45	1·89	1·94	1·04	2·96		
313	50·00	1	June 12	June 24	233	1·57	30·32	3·35	26·97	0·54					2·41		Alfalfa	No record of
		2	July 25	Aug. 9	337	2·73	76·33	11·70	64·63	1·29	1·83	0·53	2·36	2·42				total yield.
314	35·09	1	June 11	June 15	85	2·10	14·79		14·79	0·42					2·28		Alfalfa	Seeded 1914
		2	July 19	July 30	269	1·48	33·02	5·18	27·84	0·79	1·21	0·45	1·66	1·54	1·40	3·68		
315	50·00	1	June 3	June 13	241	2·36	47·15		47·15	0·94					2·09		Alfalfa	" 1914
		2	July 15	July 25	234	3·80	73·80	13·50	60·30	1·21	2·15	0·45	2·60	2·19	1·29	3·38		
324	32·73	1	May 27	June 4	190	0·98	15·39	2·25	13·14	0·40					2·84		Alfalfa	" 1914
		2	Aug. 4	Aug. 17	263	1·76	38·49	2·25	36·24	1·11	1·51	0·45	1·96	1·47	1·09	3·93		
329	11·00	1	June 7	June 13	135	1·07	12·00	0·50	11·50	1·05					1·90		Alfalfa	" 1914
		2	July 10	July 14	101	1·35	11·32	0·55	10·77	0·98	2·03	0·45	2·48	2·64	0·82	2·72		
334	16·40	1	June 4	June 11	166	0·89	12·22	0·38	11·84	0·72					2·25		Alfalfa	" 1914
		2	Aug. 1	Aug. 15	337	0·77	21·46	1·14	20·32	1·24	1·96	0·53	2·49	2·18	1·04	3·29		
303	22·50	1	May 19	May 27	188	0·84	13·07	5·11	7·96	0·35	0·35	0·36	0·71	0·96	1·03	1·03	Timothy	" 1914
			Average for forage crops								1·49	0·45	1·94	1·86				

DUTY OF WATER TRACTS, COALDALE, ALBERTA, 1921

Plot No.	Acres	Irrigation					Acre-feet per Acre								Yield	Crop	Remarks
		No.	Began	Ended	Duration in Hours	Average Head in C.F.S.	Supplied	Wasted	Used	Used per Acre	Duty	Rainfall April 1 to Harvest	Total Depth Rec'd	Total Depth Used	Bushels per Acre		
309	43·00	1	June 30	July 5	111	1·00	9·16	....	9·16	0·21	0·21	0·45	0·66	1·24	39·56	Oats	
328	6·20	1	June 24	June 27	65	1·43	7·73	....	7·73	1·20	1·20	0·40	1·60	1·55	57·26	Oats	
307	50·00	1	June 11	June 19	156	1·81	24·04	....	24·04	0·48	....	....	....	....	....	....	
		2	July 23	Aug. 2	295	1·35	32·95	5·58	27·37	0·55	1·03	0·53	1·56	1·42	20·40	Wheat	
316	32·14	1	June 26	July 2	141	2·25	26·39	2·50	23·89	0·74	0·74	0·44	1·18	1·48	20·10	Wheat	
331	3·20	1	June 25	June 27	33	0·96	2·63	....	2·63	0·82	0·82	0·45	1·27	1·39	31·56	Wheat	
			Average for Grain Tracts							0·80	0·80	0·45	1·25	1·42	....		
			Average for All Tracts for 1921							0·78	1·30	0·45	1·75	1·74	....		

SHOWING DEPTH OF WATER IN FEET USED ON COALDALE TRACTS, 1913 TO 1921

Crop	1913			1914			1915			1916			1917		
	Duty	Precipitation	Total Depth Rec'd	Duty	Precipitation	Total Depth Rec'd	Duty	Precipitation	Total Depth Rec'd	Duty	Precipitation	Total Depth Rec'd	Duty	Precipitation	Total Depth Rec'd
Alfalfa	1·70	0·98	2·68	2·11	0·57	2·68	0·68	1·32	2·00	0·41	1·56	1·97	1·31	0·68	1·99
Timothy	0·85	0·98	1·83	......	......	......	1·28	1·32	2·60	0·33	1·56	1·89	1·48	0·71	2·19
Wheat	0·74	0·98	1·72	......	......	......	0·22	1·32	1·54	0·00	1·73	1·73	0·78	0·41	1·19
Oats	....	....	....	1·49	0·57	2·06	0·00	1·32	1·32	0·00	1·73	1·73	....	....	....
Barley	......	......	......	1·25	0·57	1·82	0·00	1·32	1·32	0·00	1·56	1·56	......	......	......
Averages for all Tracts	1·15	0·98	2·13	1·84	0·57	2·41	0·57	1·32	1·89	0·28	1·56	1·84	1·18	0·65	1·83

Crop	1918			1919			1920			1921			Average 1913 to 1921			
	Duty	Precipitation	Total Depth Rec'd	Duty	Precipitation	Total Depth Rec'd	Duty	Precipitation	Total Depth Rec'd	Duty	Precipitation	Total Depth Rec'd	Duty	Precipitation	Total Depth Rec'd	No. of field
Alfalfa	2·00	0·31	2·31	1·66	0·47	2·13	1·31	0·81	2·12	1·59	0·46	2·05	1·42	0·80	2·22	81
Timothy	1·30	0·30	1·60	1·25	0·25	1·50	0·80	0·78	1·58	0·35	0·36	0·71	1·02	0·76	1·78	12
Wheat	1·16	0·29	1·45	1·18	0·38	1·56	0·47	0·81	1·28	0·86	0·48	1·34	0·78	0·80	1·58	26
Oats	1·04	0·28	1·32	1·15	0·42	1·57	0·55	0·80	1·35	0·70	0·43	1·13	0·80	0·79	1·59	15
Barley	......	......	......	......	......	......	......	......	......	......	......	......	0·21	1·15	1·36	6
Averages for all Tracts	1·70	0·30	2·00	1·33	0·43	1·76	1·11	0·81	1·92	1·30	0·45	1·75	1·16	0·79	1·95	140

The preceding table shows the average total depth of water received for the Coaldale tracts from 1913 to 1921. The average total depth of water received for the grain crops was 1·51 feet: the average duty of water for the same period for grains was 0·60 foot. For the alfalfa and grasses the average total depth received for nine years was 2·00 feet and the average duty 1·22. For all tracts under consideration the average total depth received for the nine-year period was 1·95 feet; the average duty 1·16 feet.

DISCUSSION OF SUMMARIZED DATA

The duty of water for any locality will vary from year to year, principally in accordance with the amount and seasonable distribution of the precipitation, and to a lesser extent as influenced by temperature and the condition of soil and subsoil. Therefore, in order that the water requirements of crops may readily be compared, from one year to another, or between different localities, it is best to consider that crops annually receive a certain amount of water—precipitation plus irrigation—and to designate this amount as the "Total Depth Received".

The first table following shows comparisons between Coaldale, Ronalane, Brooks, and Strathmore for temperature, precipitation and evaporation.

The second table is inserted to show the climatic conditions prevailing during the years 1914 to 1921 inclusive at the four stations from which data have been taken for use in the general discussion on duty of water which follows.

The third table is inserted for purposes of comparison and shows the average climatic conditions which prevailed during the seven years as compared with long term averages. In these tables the data cover the period April to September inclusive.

The small chart indicates the different soil conditions at Strathmore, Ronalane, Coaldale, and Brooks.

The fourth table gives a summary of the data collected from the Coaldale, Ronalane, and Brooks stations during the period 1913 to 1921 inclusive. It is not intended to quote these figures as representing the exact depths required for the various crops, but rather as showing the results of investigations to date. The column headed "Yield" is inserted as a useful index to the crops produced at these three stations. The column headed "Depth" shows in feet the total depth of water received (irrigation plus precipitation).

The *average depth* shown is the average of the depths at the different stations weighted according to the number of years during which records have been taken at each place. The column marked "Average Depth" shows the average for Coaldale, Ronalane, and Brooks.

The data at Coaldale are based on the results gained by average farmers irrigating their own fields and cover a period of eight years,—the yields at Coaldale have been omitted because they would not be comparable with the results obtained at the other places.

The results at Ronalane are based on plot work carried on consistently for six years. The results at Brooks are based on accurate and consistent plot work covering a period of four years. For Ronalane and Brooks the figures shown represent the average, at each place, of the total depths of water producing the maximum crop yield in each year. For Coaldale the figures represent the average for ordinary crops in each year.

The mean summer precipitation for the past five dry years 1917 to 1921 inclusive was:—

At Ronalane	0·49 ft.
At Brooks	0·54 ft.
At Coaldale	0·62 ft.
Mean of three stations	0·55 ft.

We find, therefore, that even during the past five dry seasons in southern Alberta we have had enough precipitation, when added to the legal duty, to produce the optimum possible duty.

TABLE SHOWING COMPARISONS BETWEEN COALDALE, RONALANE, BROOKS AND STRATHMORE FOR TEMPERATURE, PRECIPITATION AND EVAPORATION

NW. 25–8–20

Coaldale El. 2828·1

	1915	1916	1917	1918	1919	1920	1921
Evaporation—							
April	5·68	1·51	2·55	3·20	6·59	3·31	2·05
May	4·28	5·12	4·83	6·76	5·20	5·68	3·69
June	2·26	4·68	5·78	7·88	7·30	6·47	6·62
July	4·38	6·20	9·20	7·68	8·12	6·92	6·55
August	4·97	4·70	5·23	6·79	6·91	5·76	6·09
September	2·93	3·59	4·35	3·76	3·81	4·80	4·28
Sums	24·50	25·80	31·94	36·07	37·93	32·94	29·28
Precipitation—							
April	0·00	0·26	0·70	0·15	0·53	3·54	0·54
May	2·99	4·12	0·86	1·03	1·86	1·59	1·28
June	5·31	3·82	2·11	0·65	0·66	1·09	0·86
July	5·15	2·47	0·29	0·93	1·27	3·21	2·17
August	0·28	3·25	1·88	1·23	1·20	0·29	0·55
September	2·11	4·79	2·82	0·41	2·14	0·31	1·21
Sums	15·84	18·71	8·66	4·40	7·66	10·03	6·61
Temperature—							
April	50·0	44·2	39·2	42·8	45·4	31·1	41·2
May	51·1	48·6	49·7	44·0	49·0	47·6	51·0
June	54·7	56·4	56·4	63·0	58·3	57·0	62·8
July	59·3	63·3	68·5	64·3	65·9	69·0	64·6
August	67·2	60·8	63·5	63·5	66·7	68·1	62·7
September	50·4	53·6	55·1	57·4	54·8	55·4	50·3
Average	55·4	54·5	55·4	55·9	56·7	54·7	55·4

NW. 5–13–12

Ronalane El. 2330

	1915	1916	1917	1918	1919	1920	1921
Precipitation—							
April	0·09	0·14	0·84	0·21	2·34	0·90	0·61
May	1·69	2·33	0·76	0·65	1·62	1·54	1·74
June	4·15	4·32	1·29	1·22	0·37	0·66	0·74
July	3·26	4·24	0·24	1·37	0·89	2·22	1·21
August	0·75	1·68	1·34	0·92	0·77	0·00	0·57
September	1·29	3·14	1·53	0·22	0·83	0·03	1·96
Sums	11·23	15·85	6·00	4·59	6·82	5·35	6·83
Temperature—							
April	51·4	43·9	37·7	42·2	45·5	33·6	42·9
May	53·0	48·7	51·6	49·8	53·6	50·4	52·4
June	56·4	57·6	57·8	64·1	63·1	59·7	66·3
July	61·2	65·8	69·9	65·0	67·3	69·5	68·3
August	69·2	62·1	62·6	64·4	66·6	65·8	64·8
September	51·5	53·3	55·1	55·0	54·6	56·9	50·7
Average	57·1	55·2	55·8	56·8	58·4	56·0	57·5

TABLE SHOWING COMPARISONS BETWEEN COALDALE, RONALANE, BROOKS AND STRATHMORE FOR TEMPERATURE, PRECIPITATION AND EVAPORATION—*Continued*

SE. 6-19-14
Brooks El. 2455

	1915	1916	1917	1918	1919	1920	1921
Evaporation—							
April	....	....	....	5·68	2·47	1·05	2·64
May	....	....	....	8·47	6·07	4·28	3·69
June	....	....	....	8·50	7·33	5·73	5·77
July	....	....	....	9·57	7·15	5·15	6·29
August	....	....	....	6·80	5·21	5·65	6·01
September	....	....	....	3·84	3·21	4·12	3·22
Sums	....	....	....	42·86	31·44	25·98	27·62
Precipitation—							
April	....	....	0·58	0·00	1·41	1·16	0·95
May	....	....	1·01	0·42	1·02	0·88	1·55
June	5·41	2·27	0·89	0·54	0·40	1·52	0·21
July	1·55	2·61	1·06	1·39	1·46	1·41	1·44
August	2·07	1·80	2·45	1·15	2·40	0·00	1·46
September	0·65	2·45	0·82	0·31	1·77	0·00	2·65
Sums	....	....	6·81	3·81	8·46	4·97	8·26
Temperature—							
April	48·2	43·0	39·0	46·0	43·8	34·6	41·5
May	50·0	47·0	52·0	52·0	53·1	53·8	50·3
June	56·4	58·0	58·3	65·0	62·4	59·4	64·6
July	62·0	66·0	70·5	67·5	66·3	69·0	67·3
August	70·0	62·0	63·9	64·2	64·5	64·6	63·2
September	51·0	52·0	54·3	53·2	54·8	55·5	50·0
Average	56·3	54·6	56·3	58·0	57·5	55·6	56·1

NE. 11-24-25

Strathmore El. 3190

	1915	1916	1917	1918	1919	1920	1921
Evaporation—							
April	4·22	2·59	2·09	2·88	4·15	2·05	3·00
May	4·73	3·46	3·70	4·58	6·42	3·00	4·76
June	4·33	4·59	4·60	5·83	6·42	4·20	6·02
July	6·47	4·84	5·88	6·13	5·46	4·47	6·27
August	4·25	3·16	3·66	4·01	3·65	4·47	3·59
September	2·27	2·66	2·27	2·62	1·64	3·67	2·69
Sums	26·27	21·30	22·20	26·05	27·74	21·86	26·31
Precipitation—							
April	0·11	0·44	0·56	0·39	1·45	2·11	0·84
May	3·42	4·51	3·26	1·08	2·26	1·78	0·71
June	4·77	2·02	2·30	0·22	1·10	1·72	1·14
July	4·89	3·42	0·51	1·10	1·56	2·87	2·70
August	1·48	3·13	2·48	2·10	3·46	0·27	2·99
September	2·56	2·60	1·05	0·82	3·26	0·08	0·63
Sums	17·23	16·00	10·16	5·71	13·09	8·83	9·01
Temperature—							
April	46·6	41·0	35·1	41·2	41·9	27·7	38·6
May	48·6	44·4	47·2	48·5	47·4	46·0	49·2
June	51·7	53·9	54·2	59·9	56·1	55·5	60·3
July	57·2	59·1	64·9	62·6	61·7	65·0	61·8
August	64·4	56·7	59·0	55·5	60·4	60·8	58·9
September	47·0	48·5	51·8	49·0	49·5	51·3	47·0
Average	52·6	50·6	52·0	52·8	52·9	51·0	52·6

TABLE SHOWING COMPARISONS BETWEEN COALDALE, RONALANE, BROOKS AND STRATHMORE FOR TEMPERATURE, PRECIPITATION AND EVAPORATION—*Concluded*

Average for 7 years

	Temperature	Precipitation	Evaporation
	°	Inches	Inches
Coaldale	55·4	10·27	31·21
Ronalane	56·7	8·09	
Brooks	56·3		
Strathmore	52·1	11·43	24·53

COMPARISON OF CLIMATIC CONDITIONS

	Precipitation								Temperature							
	1914	1915	1916	1917	1918	1919	1920	1921	1914	1915	1916	1917	1918	1919	1920	1921
	Feet	Feet	Feet	Feet	Feet	Feet	Feet	Feet	°F	°F	°F	°F	°F	°F	°F	°F
Strathmore	0·71	1·44	1·33	0·85	0·48	1·09	0·74	0·75	52·4	52·6	50·6	52·0	52·8	52·9	51·0	52·6
Ronalane	0·38	0·93	1·32	0·50	0·38	0·57	0·45	0·56	59·4	57·1	55·2	55·8	56·8	58·4	56·0	57·5
Coaldale	0·57	1·32	1·56	0·72	0·37	0·64	0·84	0·55	55·9	55·4	54·5	55·4	55·9	56·7	54·7	55·4
Brooks	......	......	......	0·57	0·32	0·70	0·41	0·92	55·6	56·3	......	56·3	58·0	57·5	55·6	56·1

	Precipitation		Temperature	
	1914–1921	Long Term.	1914–21	Long Term.
	Feet	Feet	°F	°F
Calgary	0·77	1·00	54·32	52·51
Medicine Hat	0·72	0·77	59·06	59·01
Lethbridge	0·81	0·96	54·76	55·64

Calgary—index for Strathmore—long term records 1885–1921. Medicine Hat index for Ronalane and Brooks—long term records 1884–1921. Lethbridge—index for Coaldale—long term records, 1903–1921.

DIAGRAM SHOWING TYPICAL SOILS OF

	Strathmore	Ronalane	Coaldale	Brooks
First Foot	Sandy soil	Fine sandy loam soil	Clay Loam	Fine Sandy loam
Second Foot	Fine sandy soil to depth varying from 3 to 7 feet.	Sandy loam	Light clay loam very uniform, has no impervious stratum.	Very uniform soil. Very fine sand and silt. Light gravel at 12 to 14 feet depth.
Third Foot				
Fourth Foot				
Fifth Foot	Heavy clay and gumbo subsoil. Very impervious.	Sand and Gravel		
Sixth Foot				

SUMMARY OF CROP DATA

Crop	Coaldale		Ronalane		Brooks		Average Depth
	Yield	Depth	Yield	Depth	Yield	Depth	
Wheat	....	1·41	45·9	1·91	44·8	2·06	1·72
Oats	....	1·52	91·4	2·15	100·1	1·90	1·83
Barley	....	1·61	58·5	1·74	56·4	1·89	1·76
Peas	....	....	44·0	2·31	56·2	2·32	2 31
Potatoes	....	0·83	371·0	2·03	312·0	1·95	1·78
Flax	....	....	....	....	24·4	1·95	1·95
Alfalfa seed	....	....	....	....	8·4	1·34	1·34
Alfalfa	....	2·16	3·32	2·13	5·82	2·96	2·31
Grasses	....	1·94	....	....	1·73	1·72	1·88
Sugar Beets	....	....	1·35	1·66	16·2	1·82	1·71

The average depth noted in the above table indicates quite clearly the total depths required for the crops listed, when grown in that part of Alberta lying south of township 28, and exclusive of that strip of country lying immediately east of the foothills.

Assuming, as in previous reports, that eventually all irrigated farms will be seeded down, one-half to alfalfa and one-half to common grains, we have:—

Average depth for wheat, oats and barley .. .. 1·77 feet
Average depth for alfalfa.. .. .. 2·31 "
Then, total required for entire farm unit.. .. .. 2·04 "

With legal duty at 1·50 feet, under this condition we would need to rely on the seasonal precipitation to make up the additional 0·50 foot.

REPORT OF THE SUPERVISING HYDRAULIC ENGINEER OF THE DRAINAGE DIVISION, J. S. TEMPEST, M.E.I.C.

During the fiscal year ended March 31, 1922, drainage investigations, inspections and construction were carried on in Alberta, Saskatchewan, and Manitoba as shown in the following schedule.

ALBERTA

Project	Class of Work	Engineer
Rocky Mountain House District	Location survey	G. F. Richan.
Manawan Lake	Reconnaissance survey	F. H. Cooper.
Spotted Horse Lake	" "	F. H. Cooper
Chip Lake	" "	G. H. Wood.
Tomahawk Creek Dist	" "	G. H. Wood.
Shoal Lake	" "	G. H. Wood.
Lanes Lake	Location "	W. C. Warren.

MANITOBA AND SASKATCHEWAN

Carrot River Triangle	Reconnaissance survey	G. F. Horsey.
Waterhen Lake	Construction	A. C. Wright.
Ponass Lake	Additional surveys	W. T. McFarlane.

ALBERTA AND SASKATCHEWAN

Small Private Projects	Inspections and Surveys	D. Whittaker.

An analysis of the drainage investigations made shows that the numerous projects vary greatly in character and that the amount of time and labour required to complete the reclamation of the land after the construction of the drainage works is dependent upon these characteristics. Practically every project presents a peculiar and distinct problem in itself and greater ingenuity is often required in determining the method of treating the land after drainage than in designing the drainage works. Lands requiring drainage may be divided into four principal classes and a project may include one or more of these classes.

I. *Lands Bare of Vegetation.*

In order of value and economy of total reclamation, those lands that are bare of vegetation, other things being equal, come first. They are to be found in the beds of lakes and sloughs where the depth of water is sufficient to prevent the growth of rushes, flags and aquatic reeds and grasses. The feasibility of their reclamation is dependent principally on the cost of the drainage works, for as soon as drained the land is usually ready for seeding to timothy or other grasses without waste of time or any great expenditure of labour. After two or three years as hay meadows such lands are usually suitable for ordinary farm crops. The following are examples of the successful reclamation of this class of land. There have been no failures, although some have been more successful than others.

Mr. E. Diewert cut two and one-half tons per acre of mixed timothy and red-top the first year after draining swamp lands in sections 13 and 14, township 49, range 22, west of the 4th meridian. In succeeding years as the land became drier the red-top was gradually supplanted by timothy and the higher portions of the project were ploughed and seeded to grain.

Mr. L. A. Demers drained a lake in township 58, range 27, west of the 4th meridian in the spring of 1919 and immediately seeded it to timothy and alsike, five pounds of the former and one of the latter to the acre, while the land was still wet and without any preparation whatever. He cut two tons of hay to the acre over a portion of the area the same year and three tons to the acre in 1920. In 1921 the yield was not so great as the crop was hailed out early in the season.

Mr. D. Cameron drained a lake in the west half of section 18, township 50, range 22, west of the 4th meridian, in the spring of 1921 and immediately seeded a portion to timothy, cutting two and one-half to three tons to the acre. The grass stood 3·3 feet high with heads six inches in length.

A lake near Beaumont in township 50, range 24, west of the 4th meridian, approximately 50 acres in extent was drained and for three years the timothy crop has been sold standing, for prices varying from $1,000 to $1,700.

Similar results may confidently be expected from the reclamation of other similar lands that have been investigated by the Drainage Division.

Waterhen lake (now under construction) and Ponass lake in Saskatchewan;
Winagami, Kimiwan, Big, Cygnet, and Flat lakes in Alberta, and
Saskevam lake in Manitoba.

II. *Wild Hay Lands.*

Next in order of value and economy of reclamation are the native hay lands periodically flooded or permanently in a wet state. The common cause of these wild hay meadows is the building of beaver dams and the consequent submersion of extensive tracts of low lying land. The timber is killed by the flooding and in course of time falls and decays. Then follows the filling up of the area with silt and the growth of sub-aquatic plants including water grasses, the latter finally gaining the ascendency. These meadows are commonly admirably adapted to and capable of irrigation or spring flooding after drainage by the construction of hold-up gates at the outlet.

After the draining of Kleskun lake in township 73, range 4, west of the 5th meridian, the owners were able to cut each year upwards of 5,000 tons of red-top, reed meadow grass, and slough grass of fair food value that formerly could not be reached by the mower.

Cygnet lake near Red Deer, Alberta, was lowered by a drainage ditch dug to facilitate railway construction resulting in the reclamation or partial reclamation of about 3,000 acres of lake bed and slough. Lands formerly growing a coarse kind of reed meadow-grass and slough grass became available for farming purposes and the growth of a higher class of hay, while the lower portions formerly totally and permanently submerged are now producing coarse wild grasses that can be cut and harvested in dry and normal years.

A portion of Waterhen Marsh covered by a luxuriant growth of red-top and slough grass was too wet to be reached by the mower until the water was let off in August, 1921, by the drainage canal constructed by the Dominion Government, thus enabling the settlers to cut a large acreage of hay that otherwise would have been wasted.

Projects including lands of this class that have been investigated by the Drainage Division comprise a large portion of the 85,000 acres of Moose Range Centre and Moose Range West in northern Saskatchewan, portions of Cygnet lake, Shoal lake, Manawan lake, Athabaska district, Rocky Mountain House district, Magloire lake, Majeau lake, and Lanes lake in Alberta.

The lake beds of these projects commonly are bare of vegetation and belong to the first class of reclamation land while the shores and the higher parts of the wet area belong to the second class of grass land.

III. Flags, Rushes, and Floating Bogs.

Between the two classes of reclaimable lands already described there lies in many projects a third class that presents a more difficult problem. Where the water is too deep to permit the growth of more or less useful wild grass and yet not deep enough to preclude the growth of semi-aquatic plants there is commonly a dense growth of flags, rushes, and a condition known as "floating-bog." After draining such areas there remains an exceedingly difficult problem; one which has taxed the ingenuity of pioneers for many years. The dense mass of tangled roots and semi-decomposed vegetable matter retains water like a sponge and perpetuates the growth of a worthless vegetation sometimes for years, notwithstanding the proximity of deep and well constructed drainage channels. The tramping of cattle or the lucky advent of a succession of dry years and possibly the burning of the dry plants and the top part of the roots expedites final reclamation. Projects consisting largely of lands of this character, although reclaimable, should be undertaken with great caution. The method of their final reclamation is still in the experimental stage and while it might be good policy to clean up such areas when they form only a small proportion of a project, disappointment and loss might result in undertaking their reclamation where they form the major portion of the project.

Mr. L. A. Demers in draining the lake mentioned above failed to reclaim entirely in the first two years an area growing rushes and cat-tails, although each year showed the timothy and red-top encroaching on the rushes and flags and supplanting the inferior vegetation.

In the Kleshun lake project certain areas of flags and rushes remained in a wet and sodden state for two seasons after draining the lake, although portions of the lake bed of lower elevation where there was no growth were successfully seeded down to timothy.

The character of the vegetation should be carefully studied before any drainage project is undertaken even when the soil conditions and engineering possibilities are most favourable.

IV. Muskegs.

Finally there is the fourth class of land presenting the greatest difficulty of all to final reclamation after drainage, viz., the areas commonly known as "muskegs." These are lands consisting of from one or two feet to eight or ten feet of sphagnum moss, often covered with a growth of decrepit and dwarf spruce and tamarack of no commercial value and usually so sparse and small as to be cleared at very little cost. The deep accumulation of moss is the difficulty overshadowing all others.

Explorations show that muskegs practically hundreds of miles in extent occupy a large portion of the north country, and systematic soundings from the railroads to Hudson bay show a depth of moss varying from one to as much as twelve feet although the latter depth is exceptional. The usual depth is from two to four feet and the underlying soil, although variable, is usually clay and silt suitable for farming land when reclaimed.

Muskegs comprising portions of drainage projects and small muskeg patches on homestead lands have been successfully reclaimed and converted into good farm land, but no systematic method of treatment after drainage has yet been generally adopted. The subject is still in the experimental stage as far as the deeper muskegs are concerned, but where only two or three feet of moss overlie a suitable subsoil, successful and economical reclamation is fairly assured.

Experiments in the reclamation and cultivation of this class of land are now being carried on at agricultural experiment stations in Canada and the United States. The purpose of these experiments, however, is to ascertain what elements in the shape of fertilizers should be added to the peat soils to make them productive or more productive. Such methods, while interesting to agricultural science and to practical farmers in settled districts where farm land is of high value, are of little practical value in a pioneer country. The reclamation of muskeg and peat lands will of necessity for the present be confined to such areas as can be reclaimed by drainage and the inexpensive practice of burning or trampling by cattle. Peat soils are commonly deficient in available phosphates and potash and these are left in limited quantities in the ash of plants after burning. Where the subsoil is clay and the peat soil or vegetable matter can be burned so that the plough can reach it, an ideal condition for agriculture is obtained. A few examples of this class of reclamation are described in the following paragraphs.

Mr. Sale drained about 60 acres of muskeg on the northwest quarter of section 18, township 67, range 21, west of the 4th meridian, burned off the trees and two to four feet of moss and has raised each year since an average of 100 bushels of oats to the acre.

Mr. Shanks on the west half of section 2, township 66, range 22, west of the 4th meridian, and northwest quarter of section 35, township 65, range 22, west 4th meridian, has drained and cleared about 240 acres and now raises crops of wheat and oats on land that was formerly swamp and muskeg.

Mr. Cahill, on the northwest quarter of section 19, township 67, range 21, west 4th meridian, is now growing wheat and oats on five acres that were formerly tamarack muskeg.

Mr. Underwood near Athabaska drained about 30 acres of tamarack muskeg where the moss was from two to five feet deep. The land is now used for pasture and the growth of red-top hay.

Because of the vast areas of this class of land throughout the northern parts of all the provinces, practical experiments in the reclamation of small plots, such as those mentioned above, are advisable in the interest of future settlement. In view, however, of the meagre authentic information regarding the best methods and possibilities of profitable reclamation of the various classes of

muskeg lands it is advisable to proceed with caution and not launch into large and costly undertakings until the success in smaller schemes has blazed a sure path to the desired goal.

Muskeg lands are to be found in some of the projects investigated under Part IV of the Drainage Regulations but do not comprise a considerable portion of any project. Around Flat, Winagami, and Kimiwan lakes and a portion of the Rocky Mountain House projects are some muskeg lands which would be provided with an outlet for drainage in the event of the development of these schemes.

In general, investigations have shown that in Alberta there are comparatively few feasible drainage projects and little call for drainage south of township 35 where the sloughs and lakes are usually either too alkaline to be of value for agricultural purposes when drained or are required for stock-watering purposes or bird sanctuaries. North of this line, however, precipitation is greater, alkali conditions are usually negligible and the wet areas are so much more extensive as not only to be quite unfit for settlement in their present state but often form serious barriers to transportation, retarding the settlement of tracts of good farming lands. In Saskatchewan a similar condition exists, but the line of demarkation between the lands requiring drainage and the dry belt is somewhat farther north, about township 45.

Following are brief reports of the projects investigated during the year:—

ALBERTA

ROCKY MOUNTAIN HOUSE

Townships 36, 37, 38, and 39, ranges 4, 5, 6, and 7, west of the 5th meridian

This project lies immediately south of the Canadian Pacific railway, Alberta Central Branch, near Rocky Mountain House and consists largely of wet grass lands and muskegs broken by ridges running from northwest to southeast and by numerous islands. Each section of wet land is bordered by a belt of spruce and tamarack while the higher land is generally covered with poplar and jackpine. On the higher ground surrounding the main swamp area are numerous hay sloughs which in some sections comprise nearly fifty per cent of the area.

The soil is a sandy loam with a clay subsoil. In the open or floating muskeg the surface is from three to ten feet above the clay.

This district is not subject to drought, and after drainage the precipitation would be sufficient for the needs of farm crops. It is, however, subject to summer frosts, having an elevation of about 3,200 feet. The general opinion is that this condition is largely due to the presence of such large areas of muskeg and this would appear to be borne out by the fact that some severe frosts which occurred during the time of the survey affected, generally, those slopes which faced the muskeg, while places a short distance away were untouched. Although the altitude has much to do with the low temperatures that occasionally occur in summer time, there is little doubt that drainage would modify this drawback and enable settlers to commence farming operations earlier in spring. Another and certain benefit of drainage would be the connecting up of scattered settlements by the construction of good roads which at present is impracticable. Some good agricultural areas, including a few already settled upon, are entirely surrounded by muskeg and, except in winter, are accessible only by travelling on foot at considerable risk and difficulty.

A petition was circulated among the resident owners from which it appears that they are in favour of a drainage project that would benefit their swamp lands; that they believe the swamp lands when drained can be profitably cultivated; that road building would be made possible to and across large areas

now inaccessible, and that they are willing to pay the cost of a feasible drainage scheme in the form of taxes assessed against their land according to the provisions of the Drainage Regulations.

On account of the drainage area being small and no large streams to be provided for in the drainage works, the ditches will be comparatively small.

Convenient and efficient outlets are provided in Drummond creek flowing into Clearwater river, Raven river, and Horseguard creek, flowing into Red Deer river. These streams have cut deep ravines and are close to the project so that most of the construction cost is incurred in the muskeg itself. This advantage, combined with a good fall and a comparatively small drainage area, ensures efficient drainage works at low cost.

The total area of the project is 25,010 acres of which 16,157·1 is Crown land, and 8,252·9 is patented or homestead.

Area of open muskeg and lake	15,034·3 ac.
Area of timbered muskeg and lake	8,237·1 ac.
Area of islands	1,738·6 ac.
	25,010·0 ac.

The cost of drainage is estimated at $158,610 or $6.34 per acre, as follows:—

Excavation, 586,320 cu. yds, at 20 cents	$117,264 00
8,947 rods, ditching machine exc. at 55 cents	4,940 00
Timber culverts, 45 at $30	1,350 00
Highway and form bridges, 30 at $50	1,500 00
Right of Way, 2,387 ac. at $10	2,387 00
Clearing, 12·7 ac. at $30	481 00
Improvement of outlet creeks	10,000 00
	137,922 00
Engineering and Contingencies, 15 per cent	20,688 00
Total	$158,610 00

LANES LAKE

Townships 37 and 38, ranges 14 and 15, west of the 4th meridian

Preliminary surveys were made of this project in 1920 and investigations were completed in 1921.

The lake is situated about three miles west of the town of Castor, Alberta, on the Canadian Pacific railway. The natural outlet is a small watercourse running to Sullivan lake about seven miles distant. The fall averages about 2·5 feet per mile and to afford the necessary drainage this creek would have to be improved almost its entire length. It is estimated that the run-off from Lanes lake when drained would not materially raise the level of Sullivan lake.

The lake has a normal average depth of about 3·5 to 4 feet of fresh water with considerable areas of permanently wet low-lying land around its shores, especially at the north and south ends where an abundant crop of good quality red-top is growing.

The soil is sandy loam with clay subsoil of excellent quality for agricultural purposes when drained.

Partial drainage is recommended; that is, to convert the present lake bed of 1,502·7 acres into hay lands and the present hay lands of 703·7 acres into

cultivable farm lands. The total area reclaimed would be 2,233·4 acres and the estimated cost $28,000, or an average of $12.54 per acre for the lands benefited. The drainage district contains 58 per cent of Crown land and 42 per cent of alienated land.

Farm land in the district is valued at from $30 to $40 per acre and it is expected that the reclaimed land would be even more valuable.

In view of the general desire of the resident owners and the comparatively low cost, construction is strongly recommended.

CHIP LAKE

A reconnaissance was made of Chip lake with a view to ascertaining the desirability and feasibility of draining it.

The lake is situated in townships 53 and 54, ranges 9, 10, and 11, west of the 5th meridian, on the main line of the Canadian National railway about eighty miles west of Edmonton. At normal level it has an average depth of less than six feet and covers an area of 18,000 acres.

In the district west of the lake is a wet area known as the "Forty Mile Muskeg" covering an area of approximately 40,000 acres. It was thought that the wet condition was caused by a backing up of water from the lake and that a comprehensive scheme might be devised for the reclamation of lake and muskeg, making available for agricultural purposes a total area of ninety square miles.

The attention of the department was originally drawn to this reclamation project in 1914 when the Western Reclamation and Development Company of Edmonton applied for permission to purchase the area under conditions of drainage. The application was, however, allowed to lapse.

The comprehensive scheme includes two distinct classes of land, the bed of the lake bare of vegetation which after draining would be immediately ready for seeding to tame grasses, and the Forty Mile Muskeg of typical muskeg land, the final reclamation of which after drainage involves an unknown time and uncertain expense. The investigation showed, however, that the drainage of the 40,000 acres of muskeg land is not dependent upon the draining or lowering of the lake. Its elevation above the high water level of the lake and the natural slope of the land are quite sufficient to ensure efficient drainage by the construction of laterals to the existing natural water courses.

The outlet of the lake is Lobstick river, a shallow, crooked stream which for seven miles below the lake has a very flat grade, but below that point drops very rapidly in a series of small rapids. The outlet river lies in a valley about thirty feet deep so that any improvement of the channel to increase its capacity would follow its present course.

The drainage of the lake involves provision of a channel sufficient to accommodate the discharge of the Lobstick river through the bed of the lake and the improvement of the present channel below the lake for over seven miles.

The most feasible scheme would be the total reclamation of 1,415 acres and the partial reclamation for the growth of hay of 6,472 acres. The cost of such a scheme would be $518,617 or an average of $29 per acre.

The lake at present serves no purpose except as a natural but shallow reservoir, useful only for its regulating effect on stream flow.

Although lying close to the railroad this district is not well settled owing to the large extent of the muskeg lands in the vicinity. Partly improved land can be purchased from the original homesteaders at from $10 to $25 per acre.

Judging from the interviews with settlers in the district there is no marked demand for drainage except on the part of those in need of cheap hay for cattle raising.

Owing to the high estimated cost of drainage of the lake as a separate project and the uncertainty regarding the economical treatment of the surrounding muskeg lands, the reclamation of this project is not recommended at present.

TOMAHAWK CREEK

The lands in this project lie in townships 50, 51, and 52, ranges 5, 6, and 7, west of the 5th meridian, between Low-Water lake and the Pembina river, about fifty miles west of Edmonton. The original reservation was made in 1915 in connection with an application by the Northern Alberta Drainage Company to purchase the area for reclamation by drainage. This company did not prosecute its application and the project was allowed to stand over until 1921 when a reconnaissance of the district was made.

A careful examination was made of the whole area, and it was found that while small swampy areas are located throughout practically all of the district, there are no large tracts of wet land requiring and susceptible of drainage at reasonable cost. In general, the country is rolling in character, with a cover of heavy poplar, and possesses good natural drainage channels, the largest single area of swamp covering only about three sections, this being of the muskeg type. The small wet patches are apparently due to the work of beavers in bygone days, there being numerous old dams along all creeks. These obstructions to run-off can in many cases be removed without great cost by the locally interested land owners, either singly or in co-operation.

The attitude of the land-owners in regard to the project appears to have undergone a considerable change as at the present time there is no general demand for drainage. In view of this fact and as no comprehensive drainage scheme is possible, it has been recommended that the reservation be removed and the land made available for homestead entry.

SHOAL LAKE

This shallow body of water is located 80 miles by road in a northwesterly direction from Edmonton, and 30 miles west of the town of Westlock on the Edmonton, Dunvegan and British Columbia railway, in townships 60 and 61, ranges 3 and 4, west of the 5th meridian.

At normal water level the submerged area covers some 2,000 acres but during high water periods an additional 1,000 acres are flooded, as there are expanses of low-lying meadow around the greater portion of the shore line. The average depth of the lake is 3 feet, and on account of the heavy growth of weeds during low water, it is difficult to row a boat across it. The natural outlet is Shoal creek, a small debris-choked stream flowing in a valley about twenty feet deep out of its eastern end.

The possible economical drainage of this lake was brought to the attention of the department in 1919 in connection with an application to purchase the north half of section 7, township 61, range 3, under Part I of the Drainage Regulations. The reconnaissance survey shows that 3,151 acres of wet and submerged lands can be reclaimed for agricultural purposes at a cost of $43,440 or an average of $13.45 per acre.

Land values in the district are not high, as the district is not closely settled, although growing rapidly, the soil and climate being excellent. Partly improved homestead land can be purchased at from $10 to $30 per acre, but it would require considerable work to make any whole quarter into crop land. The reclaimable lake-bed is very superior to this adjacent land in soil (muck and silt with clay subsoil) and arability, and should be worth at least $20 per acre, which would show a good profit on the investment in drainage works.

The resident land owners of the locality, as far as could be learned, are unanimously in favour of drainage, eighteen of them giving written statements to this effect. Several are very enthusiastic in regard to the possible hay-growing value of the land, and are desirous of purchasing a portion should construction be carried out.

Taking the project on the whole it appears to be worthy of careful consideration and a detailed location survey is recommended.

SPOTTED HORSE LAKE

Townships 68 and 69, range 26, west of the 4th meridian

A reconnaissance survey was made of this project which is situated forty miles west of Athabaska and about fifteen miles east of the Edmonton, Dunvegan and British Columbia railway. There is a very bad road from Athabaska to the lake, but no road at all from the railway.

The area draining into Spotted Horse lake is about 164 square miles in extent and consists of large tracts of muskeg and swamp, covered with scattered growths of tamarack, spruce, poplar, and birch, with sandy ridges and sandy bottomed muskegs. To the north of the lake the soil is from six inches to a foot in depth and the subsoil is sand and boulders. To the south of the lake the soil is sandy clay with a clay subsoil.

For any other purpose than the production of hay the proposition is not worth while. As a ranching proposition the area might be improved by a number of shallow ditches and by deepening the outlet creek to drain the lake. This would cost approximately $62,000 and would insure abundant supplies of hay and pasturage for a large number of cattle, but could never be developed into a district suitable for settlement.

It would be in the public interest to permit ranchers already settled in the locality to purchase the wet hay meadows lying around the lake under conditions of partial drainage, that is draining sufficiently to permit the cutting of the hay in the low-lying swamp lands around the shores of the lake. The cost of such works would not be very great, but in wet years considerable areas would probably be under water until late in the season.

This project is not recommended as one to be initiated by the Dominion Government under the Provisions of Part IV of the Drainage Regulations.

MANAWAN LAKES

Manawan lakes are situated in a thriving farming country served by the Edmonton, Dunvegan and British Columbia railway and the Athabaska branch of the Canadian National railways. The centre of the district investigated is about twenty-three miles north of Edmonton.

The country is well settled by thrifty farmers who have been in the district for an average of ten years. All the country about the lakes is cultivated and the lakes are a hindrance to its further development. Land in the district is worth from $65 to $75 per acre. Several farmers expressed their desire to purchase the lake bed at $50 per acre should the drainage project materialize. The lakes form a barrier to traffic and seriously increase the length and difficulty of the haul to town from the east and west. The drainage of the lakes would effect a considerable saving in road maintenance and would decrease the cost of hauling grain to the elevators. From every point of view the complete drainage of the lakes would be a great advantage to the whole district and to traffic north from Edmonton through the district.

The soil of the lake bed is a good black loam and when drained would be capable of producing crops equal to the best the adjoining district now produces.

The scheme proposed would require a ditch with a bottom width of ten feet throughout the length of the larger lake to the north, following the channel between the lakes, thence through the smaller lake and from the southwesterly corner of the latter lake would follow and enlarge the present inadequate outlet until a point is reached where that outlet is large enough to carry the discharge.

The area affected consists of 2,333·6 acres of Crown lands and 7,644·4 acres alienated lands. The estimated cost of reclamation is $72,035, or an average of $2.50 per acre. On account of the proportion of Crown lands being less than fifty per cent this project could not be initiated by the Dominion Government but could be undertaken by the land owners under the provisions of the provincial drainage laws.

MANITOBA AND SASKATCHEWAN

CARROT RIVER TRIANGLE

The district known as the Carrot River Triangle comprises an area of about 1,100 square miles (or 700,000 acres) of submerged and periodically flooded lands forming an irregular triangle between the Saskatchewan and Carrot rivers with the Sipanok channel as its base. About 920 square miles of the triangle lie in the province of Saskatchewan and 180 miles in Manitoba.

Several partial investigations and surveys have been made in past years with a view to ascertaining the feasibility of reclaiming this land for agricultural purposes but owing to the magnitude of the project, the inadequacy of the staff and the short time spent on the surveys, these merely indicated that drainage appeared to be feasible and that the land when drained would be suitable for farming. One of the greatest difficulties in the investigation was the practical impossibility of penetrating to and surveying the greater portion of the interior during the open season.

When this work was taken up by the Reclamation Service in 1921 two survey parties were detailed to survey and investigate the drier portions along the banks of the Saskatchewan and Carrot rivers during the summer and to establish bench-marks and base lines. Two more survey parties were assigned to the work in the late fall and the full force of four parties rushed the investigation of the interior as soon as the freeze-up made it possible to traverse the swamps and muskegs. Three parties continued work until the middle of December and a third party remained until the end of January, 1922. The whole area has, however, not yet been covered and another season's work is required before a final recommendation can be made as to the feasibility and cost of the project.

From the information now available two alternative schemes suggest themselves:—

A. The reclamation of the whole area by the construction of levees to keep out the flood waters of the Saskatchewan and Carrot rivers and a combined system of gravity drainage and pumping to take care of the run-off due to precipitation.

B. The reclamation for the present of only the eastern portion of the triangle lying entirely in the province of Manitoba by the construction of levees around the whole of this portion and dealing with the run-off derived from precipitation by a pumping system.

Scheme "A"

Scheme "A" involves the reclamation of the entire triangle consisting of 704,000 acres. The area is largely a mass of shallow lakes and open marshes with higher land along the boundary rivers, with a gradual slope to the east.

The soil in the eastern area is an alluvial deposit of clay with from six inches to a foot of black muck, while in the central portion a large part consists

of black muck or moss muskeg to a depth of from two to nine feet, with a subsoil of clay. The soils of the western portion have not yet been investigated. The higher land on the Saskatchewan and Carrot rivers, as well as along the interior water courses, is a clay silt.

Timber, consisting largely of poplar and willow, forms a belt ranging in width from two hundred feet to two miles, along the main rivers and bordering the smaller streams in the interior. Possibly ten per cent of the whole area is timbered.

The scheme would require the construction of a system of levees on the south bank of the Saskatchewan river from near the mouth of the Carrot river to a mile west of Sipanok channel and levees on the north bank of the Carrot river from the same point west to the Sipanok channel and extending up this channel eight miles to high land.

The interior would be divided into three drainage districts.

District No. 1, including the northern portion of the central and western sections, would be drained by means of a main canal running from west to east and laterals at intervals of two miles. The outlet of this main canal would be near the provincial boundary, discharging its water by pumping into the Saskatchewan river.

District No. 2 would include the southern portion of the central and western section. The interior drainage would be effected by means of one canal running in an easterly direction, with laterals every two miles, to an outlet about thirteen miles west of the provincial boundary, and an additional canal and necessary laterals running from the eastern boundary 12·74 miles west to the same outlet. A pumping plant would be established at this outlet, and the water pumped into the Carrot river.

District No. 3 would include the entire eastern section. The interior drainage would be provided for by the construction of eight canals leading to a main canal which would have its outlet near the eastern end of the triangle where a pumping plant would be installed and the water pumped into the Saskatchewan river.

Investigations do not yet warrant any estimates of cost being given, nor, in fact, any definite statement of the economic feasibility of the scheme.

Scheme "B"

Scheme "B" involves the reclamation of only a part of the Triangle, consisting of an area of 113,472 acres. This area is wholly in the province of Manitoba and from general appearances has the most suitable soil for agricultural purposes in the district investigated, and could be put under cultivation with but little preparation after drainage.

This scheme would include only the portion of Scheme "A" as described under District No. 3 of that scheme. It would require the same canals and pumps as proposed for District No. 3 as well as levees on both the Saskatchewan and Carrot rivers, and a connecting levee joining these near the provincial boundary. The area to be reclaimed under this plan would be entirely surrounded by levees and the interior protected from the flood waters of the adjacent rivers.

It is estimated that the cost for reclamation under this scheme would be approximately twice as great as under Scheme "A".

WATERHEN LAKE

Townships 44, 45, 45a, ranges 21 and 22, west of the 2nd meridian

The contract for the construction of the Waterhen Lake Drainage Project was let to the Lount Engineering Company and the work of excavation commenced in May, 1921.

The excavation of the main canal, consisting of enlarging the bed of the Carrot river and a few minor cut-offs, was done by means of a 2-yard Lidgerwood complete-circle drag-line excavator with 60-foot boom. This machine worked from May 19 to November 11 when operations were suspended on account of freeze-up. In 121 working days 170,320 cubic yards of earth were moved, making an average of 1,408 cubic yards per day. The material consisted of thirty per cent hardpan and seventy per cent clay.

The Marsh canal excavation was carried on by means of a drag-line excavator identical with the one used on the main canal. Operations were carried on under one to two feet of water on the marsh land until the water was let off in August. The machine commenced work on May 26 and worked until September 30, moving 107,873 cubic yards in eighty working days or an average of 1,348 cubic yards per day. The material consisted of 10 per cent marl, from 50 per cent to 75 per cent muck and the rest clay.

The Lake canal was excavated by means of a $1\frac{1}{4}$-yard floating dipper dredge, Bay City type. Work was commenced on May 26, and continued until the freeze-up, November 8, moving 154,388 cubic yards of earth in 112 working days or an average of 1,378 cubic yards per day. The material was 100 per cent clay.

The east end of the Lake canal on dry land was excavated by means of a Lount caterpiller-tread, half-circle drag-line excavator of one cubic yard capacity. This machine moved 36,830 cubic yards of earth in 24 working days, or an average of 1,535 cubic yards per day. The material was 100 per cent clay.

During the season a total of 469,411 cubic yards of earth was excavated, leaving approximately 165,000 cubic yards yet to be dug on the main lake and marsh canals. In addition to this there will be about 12,000 rods of levees to trim, 6,000 rods of catch ditches and a number of small laterals to construct as may be found necessary after draining the lake and canal; also five bridges (two with hold-up gates), a number of culverts and other details to complete the work. The construction of much of this work can only be proceeded with when the lake bed and marsh have dried sufficiently to permit the use of teams.

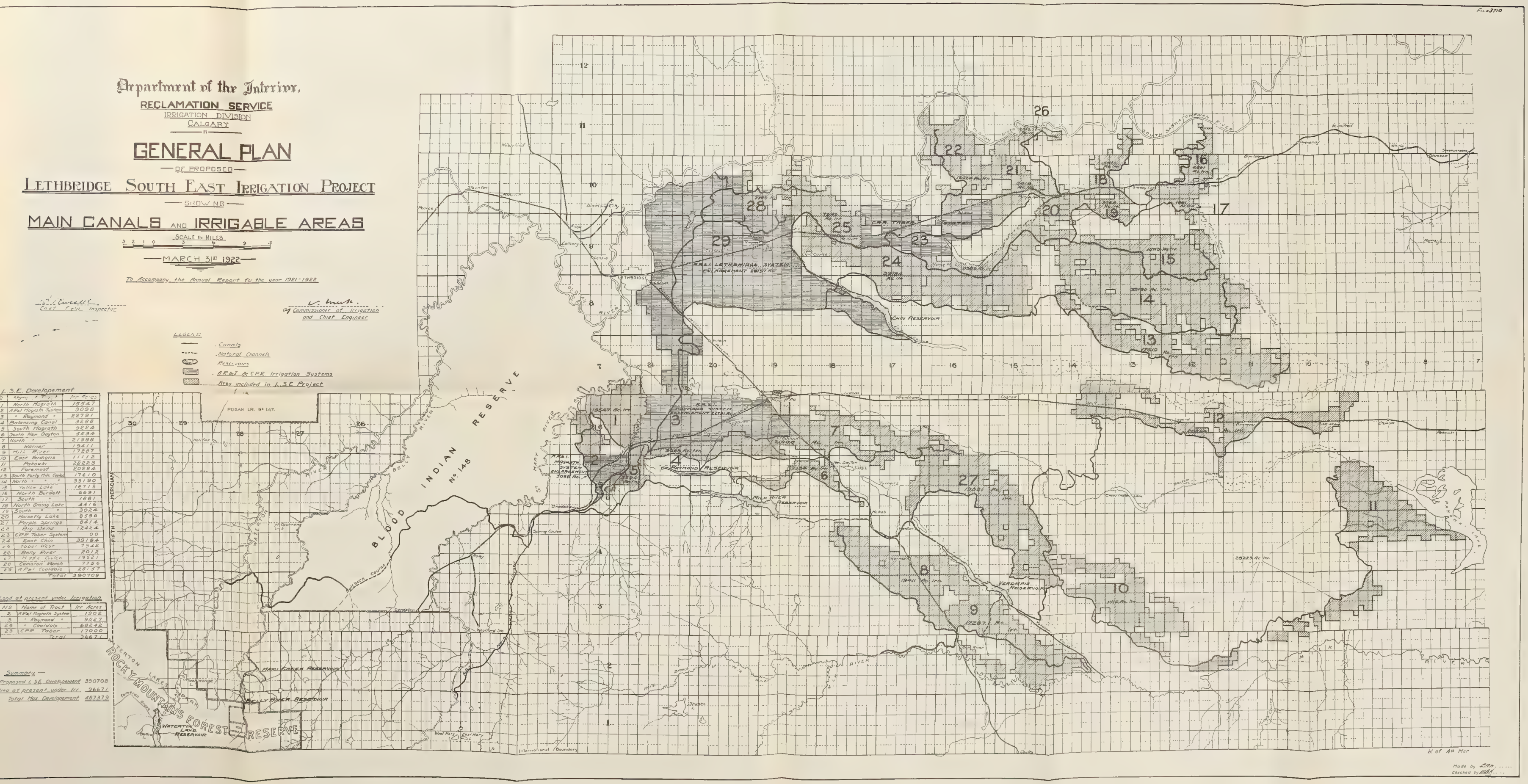
It is expected that the water of the lake will be let off about midsummer of 1922 and that all the wild hay lands will be dry enough to cut while the grass is in good condition. Last season most of this hay could not be harvested because of wet conditions except the meadows on the marsh which were drained in July.

The general progress of the various schemes under development has been good, there being no abandoned or unsuccessful schemes during the year.

PRIVATE DRAINAGE PROJECTS

Twenty-five applications were dealt with under the provisions of Part 1 of the Dominion Government Drainage Regulations and the Reclamation Acts of the province of Alberta and Saskatchewan; the necessary surveys were made and field maps and reports were compiled. In addition, twenty-six inspections were made of small drainage projects, and engineering advice and assistance were given to the owners in order that the works might produce the maximum of benefits at minimum cost of construction.

The general progress of the numerous small drainage schemes under development has been quite satisfactory. There have been no abandoned or unsuccessful schemes, and those who have actually undertaken drainage work are apparently quite satisfied that they have made a good business investment.



L.S.E. Developement

No	Name of Tract	Irr Acres
1	North Magrath	15547
2	A.R.&I. Magrath System	3098
3	" Raymond "	22791
4	Balancing Canal	3288
5	South Magrath	5224
6	South New Dayton	5534
7	North " "	21988
8	Warner	19411
9	Milk River	17287
10	East Verdigris	11112
11	Pakowki	28223
12	Foremost	20284
13	South Forty Mile Coulee	17610
14	North " " "	33190
15	Yellow Lake	16713
16	North Burdett	6691
17	South "	1881
18	North Grassy Lake	4416
19	South " "	3024
20	Horsefly Lake	8586
21	Purple Springs	8414
22	Big Bend	12424
23	CPR Taber System	00
24	East Chin	39184
25	Taber West	7342
26	Belly River	2012
27	Mode Coulee	19521
28	Cameron Ranch	7756
29	A.R.&I. Coaldale	28157
	Total	390708

Land at present under Irrigation

No	Name of Tract	Irr Acres
2	A.R.&I. Magrath System	1902
3	" Raymond "	9527
29	" Coaldale	68242
23	CPR Taber	17000
	Total	96671

Summary —

Proposed L.S.E. Developement	390708
Area at present under Irr.	96671
Total Max. Developement	487379

Department of the Interior.

RECLAMATION SERVICE

IRRIGATION DIVISION

CALGARY

GENERAL PLAN

OF PROPOSED

ROBSART-VIDORA IRRIGATION PROJECT

SCALE IN MILES

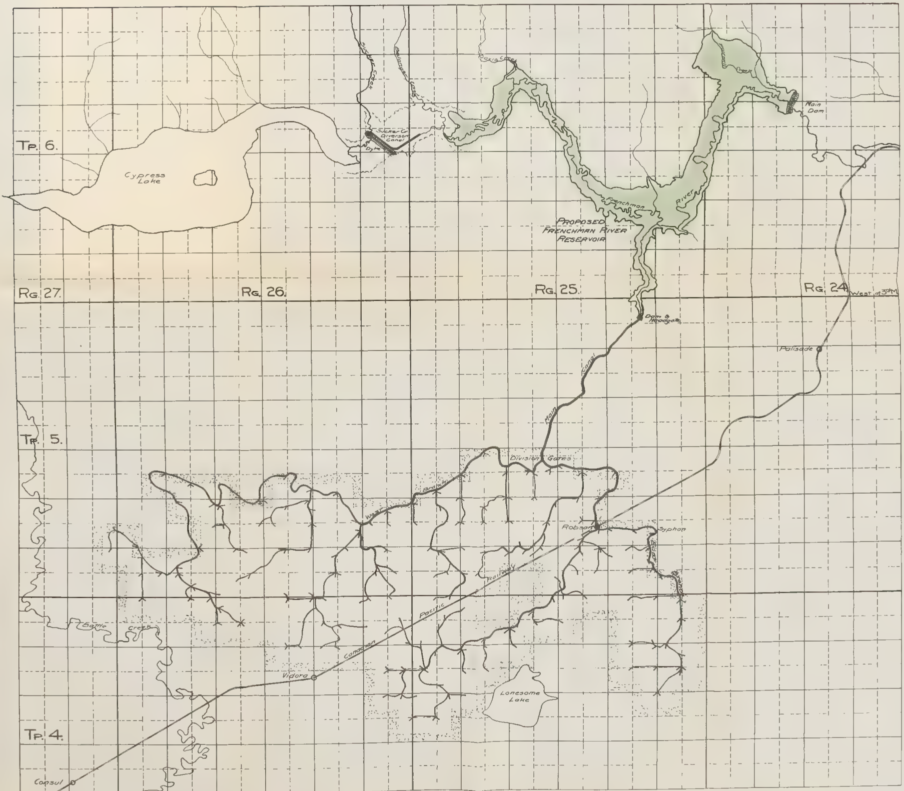
MARCH 31ST 1922

To Accompany the Annual Report for the year 1921-1922

S.H.Hawkins
Engineer in Charge

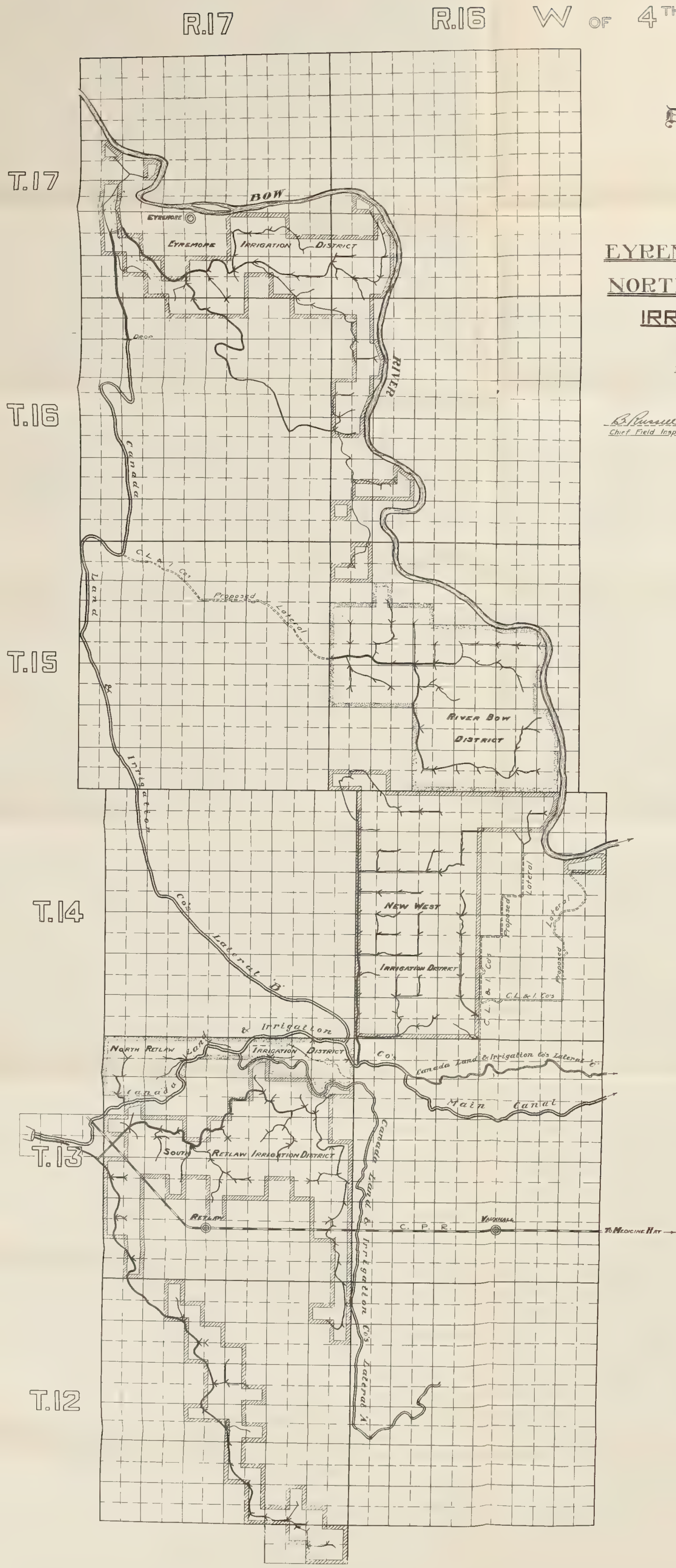
Chief Field Inspector

Commissioner of Irrigation and Chief Engineer



Prepared by

Checked by WBH



Department of the Interior.

RECLAMATION SERVICE

IRRIGATION DIVISION
CALGARY.

GENERAL PLAN

OF

—PROPOSED—

EYREMORE, RIVER BOW, NEW WEST NORTH RETLAW & SOUTH RETLAW IRRIGATION DISTRICTS

SCALE IN MILES

To accompany the Annual Report for the year 1921-22
March 31st

B. Russell
Chief Field Inspector

V. Meek
a/ Commissioner of Irrigation and Chief Engineer

DISTRICT	ESTIMATED IRR ACRES
EYREMORE	4092
RIVER BOW	3000
NEW WEST	7629·8
NORTH RETLAW	2031·4
SOUTH RETLAW	5692·9
TOTAL	22446·1

Prepared by M.H.H.
Traced by H.B.R.
Checked by P.B.

RECLAMATION SERVICE

LIST OF PUBLICATIONS

DRAINAGE REGULATIONS.

IRRIGATION REGULATIONS.

ANNUAL IRRIGATION REPORT—1912 to 1915.

IRRIGATION SURVEYS AND INSPECTIONS REPORT—1915. (1915-16). (1916-17). (1917-18). (1918-19).

ANNUAL REPORT OF THE RECLAMATION SERVICE—(1919-20). (1920-21). (1921-22).

WESTERN CANADA IRRIGATION ASSOCIATION REPORTS—(1st to 11th Convention).

INTERNATIONAL IRRIGATION CONGRESS REPORT (1914).

BULLETIN No. 1—Irrigation in Alberta and Saskatchewan.
(Consisting of a Synopsis of the Irrigation Act and its Administration).

BULLETIN No. 2—Alfalfa Culture.

BULLETIN No. 3—Climatic and Soil Conditions, C.P.R. Irrigation Block.

BULLETIN No. 4—Duty of Water Experiments and Farm Demonstration Work.

BULLETIN No. 5—Farm Water Supply.

BULLETIN No. 6—Irrigation Practice and Water Requirements for Crops in Alberta.

PAMPHLETS:

Address by Mr. S. G. Porter—"Practical Operation of Irrigation Works."—Extract from W.C.I.A. Report, 1914.

Address by Dr. Rutherford—"Inter-dependence of Farm and City."—Extract from W.C.I.A. Report, 1914.

Address by Mr. Don. H. Bark—"The Actual Problem that Confronts the Irrigator."—Extract from W.C.I.A. Report, 1914.

Address by Mr. Don. H. Bark—"Practical Irrigation Hints for Alberta."—Extract from W.C.I.A. Report, 1915.

Address by Mr. Don. H. Bark—"Alfalfa Growing."—Extract from W.C.I.A. Report, 1915.

"Practical Information for Beginners in Irrigation" (by W. H. Snelson, A.M.E.I.C.).

DEPARTMENT OF THE INTERIOR, CANADA

Hon. CHARLES STEWART, Minister; W. W. CORY, Deputy Minister

Reclamation Service E. F. DRAKE, Director

ANNUAL REPORT

OF THE

RECLAMATION SERVICE

1922-1923

OTTAWA
F. A. ACLAND
PRINTER TO THE KING'S MOST EXCELLENT MAJESTY
1924

IRRIGATION'S PART IN SUCCESSFUL TRUCK-FARMING

DEPARTMENT OF THE INTERIOR, CANADA

Hon. CHARLES STEWART, Minister; W. W. CORY, Deputy Minister

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TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

RECLAMATION

REPORT OF THE DIRECTOR OF THE RECLAMATION SERVICE, E. F. DRAKE

IRRIGATION

The series of dry years, from which the semi-arid districts of Alberta and Saskatchewan have recently suffered, has been responsible for widespread requests for surveys to ascertain what areas can be irrigated from the available water supply, and the staff of the Reclamation Service, whose duty it is to make these investigations and surveys, has had difficulty in keeping up with the demand.

CLIMATIC AND CROP CONDITIONS IN SOUTHERN ALBERTA IN 1922

The month of November, 1921, was unusually mild and there was practically no snowfall. Stock on the range was therefore in excellent shape to withstand the cold weather which came in December when, because of heavy snowfalls, considerable feeding was necessary. Mild weather prevailed throughout January, February, and part of March, and all stock came through the winter in good condition. April was cold and wet, and the land was too moist for ploughing. May, however, was warm, and good progress was made in agricultural operations. During June the temperature was about normal and the precipitation was the highest since 1916. Rain fell at intervals of a few days all through the month, and the amount and distribution of this moisture gave the crops a splendid start. July, August, and September were warm and dry with some hot winds, but the moisture remaining in the ground from the June rains carried the crops through to a fairly successful harvest.

The total precipitation in 1922 was below the average, but the occurrence of heavy rains at the proper time—April, May, and June—and the absence of drying southwest winds, were conditions directly responsible for the better crop yields; this is a striking instance of distribution of rainfall being more important than amount.

IRRIGATED CROPS

Because of the abundant rainfall in the early part of the season, irrigation was not so urgently needed as in the last few years; notwithstanding this, a larger number of acres than ever before were irrigated on the large projects, by about the same number of water users. There has always been a tendency to delay using water in the hope that there would be sufficient rainfall, and crops on irrigable land have frequently suffered on this account. This year's record indicates that the farmers are depending less upon the weather and more on their own efforts. The returns from the different projects under operation show that irrigated crops were good and the production and value in every case exceeded that of 1921, although prices were low.

PROGRESS IN IRRIGATION DEVELOPMENT

Corporation Projects.—All projects have been successfully operated during the year. As usual some mishaps and unavoidable accidents have occurred, but

repairs were quickly effected, and no serious delays in the delivery of water have been reported. Large sums of money have been spent during the year on the repair, betterment, and renewal of canal systems. New telephone lines and fences have been built, hundreds of miles of canals and distributaries cleaned out, and all canal systems are in excellent shape for the season of 1923.

On account of the stringent financial conditions existing all over the world, settlement in those projects, which still have land to sell, remains slow. The majority of settlers in these tracts have come from outside points, but this year a tendency was noticeable among the farmers in Alberta and Saskatchewan to leave their "dry" farms and take up irrigated lands. Many, who have tried irrigated farming for a few years, find that they took up too much land and are now reducing their holdings in order to farm the remainder more intensively.

Irrigation Districts.—Steady progress has been made in this form of development, under which all co-operative irrigation systems will probably be constructed in the future. The Irrigation Districts Act, enacted by the province of Alberta in 1915 and amended from time to time, has functioned efficiently, and the creation of an Irrigation Council to exercise supervision over the organization, construction, and general welfare of irrigation districts, has been a great factor in the smooth working of the Act.

Eight districts, containing a total of 212,000 irrigable acres, have been organized under the Act. One of these, the Taber district, has been in operation for two years; two, the Lethbridge Northern and United districts, have just completed construction; two, the Little Bow and New West districts, are under construction; and at least two more, the Magrath and Mountain View districts, appear likely to complete organization and proceed with construction in 1923.

As mentioned in last year's report, it is evident to close students of agricultural problems, that many of the individual holdings in irrigation districts are too large to be properly cultivated under irrigation, largely because of the high cost of the necessary work and the inexperience of many of the settlers. In order to achieve success in irrigation farming, especially when the cost of the works is high, every acre must be carefully cultivated and made to yield good returns. Generally speaking, the average farm unit should contain from 80 to 160 acres of irrigable land, while the holdings usual for "dry farming" in this country are very much larger. The Colonization Branch of the Irrigation Council, organized by the province of Alberta in 1921, has been busily engaged in remedying this difficulty. It has listed the excess land holdings to be disposed of by farmers and has carried on an active colonization campaign for the purpose of selling these lands and placing additional settlers on them. Efforts in this direction have so far been largely confined to the newly completed Lethbridge Northern irrigation district. A few sales have already been effected, and if the enquiries received and the interest shown are any guide, quite a number of settlers should be placed in this district during 1923.

In Saskatchewan many small irrigation schemes are being operated, but no large co-operative projects have yet been developed. An Irrigation Districts Act, very similar to that of Alberta, was passed in 1920, but has not yet been used. One project has, however, been surveyed and an irrigation district is in process of organization. The Act will therefore probably be brought into practical operation at an early date.

Small Irrigation Projects.—The construction of small individual projects continues to interest many farmers whose lands can be irrigated by diversion from nearby streams, and the waters of some of these streams have been practically all appropriated. Some of these small projects have been operated successfully for many years and there are at present 496 licensed or authorized

schemes. These, with other schemes not yet authorized and a large number of new applications recorded in 1922, make a total of 724 small irrigation projects under the supervision of the Reclamation Service.

IRRIGATION IN 1922

During 1922, 241,616 acres were irrigated by 2,937 water-users in the five large projects now in operation, a satisfactory feature of the season's work being the improvement in the methods of irrigating with consequent increased crop returns. The percentage of wheat to other crops is still far too high, although it is being reduced year by year as diversified crops gain in favour. Wheat crops exhaust the fertility of the soil sooner than most other crops, and do not give by any means the greatest return per acre. For instance in a certain district wheat gave a return of slightly over $20 per acre, whereas in the same district alfalfa yielded almost $50 per acre on the average.

The acreage under irrigation will be largely increased in 1923, as two districts, the Lethbridge Northern of 105,000 acres, and the United of 26,000 acres, have just been completed. These districts are well settled and their development should be rapid.

The preliminary surveys for practically all projects, large or small, were made by the Reclamation Service in pursuance of the policy of the Dominion Government that the surface water it controls shall be so allocated as to serve the public to the best advantage. In addition to the seven constructed schemes, surveys have been completed for fifteen other projects which have been found feasible and are now in different stages of organization. Surveys are now being carried on in several new projects.

DUTIES OF THE IRRIGATION DIVISION

It is the duty of the Irrigation Division of the Reclamation Service to administer the surface water supply (with the exception of water-powers) in the Prairie Provinces. This is done under the provisions of the Irrigation Act and includes the use of water for domestic, municipal, industrial, irrigation, and other purposes. To administer the water supply so that the greatest benefit may result to the public is a heavy responsibility and a large staff of engineers and helpers is needed to deal with the many different phases of the work. Because of the ever-increasing demands for irrigation the work has been growing heavier each year. The work to be done comprises:—

1 Inspection and surveys of small schemes, new or in operation.

2 Supervision of large projects under construction or in operation.

3 Duty of water experiments and climatic studies.

4 Soil surveys and experiments and seepage investigations.

5 Surveys of large projects consisting of development of reservoir sites, reconnaissance and preliminary surveys, followed by plane-table and final surveys when projects are found to be feasible.

These surveys and investigations of various kinds were carried on at a number of different points through southern and central Alberta, and south-western Saskatchewan in 1922. Good progress was made during the season, and afterwards in the office the engineers and draughtsmen were employed in preparing plans of work done in the field and making the necessary designs, studies, and cost estimates of the different projects.

The following schedule shows the development of irrigation to the end of 1922:—

IRRIGATION DEVELOPMENT IN WESTERN CANADA

Project	Source of supply	Area of tract	Irrigable area	1922 Operations: No. of water-users	1922 Operations: Area irrigated	Capital cost	Mileage of canals
		acres	acres		acres		
Constructed and in operation—							
C.P.R. Western Sec.	Bow river	1,145,336	218,980	967	49,752	$5,353,440	1,469
C.P.R. Eastern Sec.	Bow river	1,212,074	400,000	893	93,375	11,132,169	2,500
Alberta Ry. & Irr. Co.	St. Mary river	434,509	130,000	865	75,558	1,900,000	225
Taber Irr. district	St. Mary river	30,365	17,244	128	13,122	272,330	73
Under construction, partly in operation—							
Canada Land & Irr. Co.	Bow river	452,482	202,640	64	9,809	6,541,207	377
Constructed, operation to commence 1923—							
Lethbridge Northern district	Oldman river	231,220	105,000	....	....	5,400,000	
United Irr. district	Belly river	64,600	26,000	....	....	524,000	
Little Bow district	Highwood river	11,490	3,278	....	....	36,000	
Found by surveys to be feasible (district organized)—						Estimated cost	
New West district	Bow river	13,015	4,501	....	....	160,000	
Medicine Hat E. Irr. district	Ross creek	4,800	2,900	....	....	36,000	
Macleod Irr. district	Waterton river	108,603	49,649	....	....	2,060,000	
Found by surveys to be feasible (not organized)—							
Eyremore district	Bow river	18,776	4,100	....	....	250,000	
Bow River Irr. district	Bow river	16,688	5,792	....	....	314,357	
Lethbridge Southeastern district	Waterton, Belly, St. Mary, and Milk rivers	1,182,781	414,400	....	....	16,622,000	
Robsart-Vidora project	Frenchman riv.	14,000	10,000	....	....	343,841	
Retlaw-Lomond Irr. district	Bow and Oldman rivers	418,630	115,000	....	....	2,500,000	
Champion Irr. district	Highwood river	184,860	50,000	....	....	2,071,000	
Granum Irr. district	Willow creek	....	4,500	....	....	260,000	
Beaver Creek project	Beaver creek	....	9,000	....	....	450,000	
Preliminary surveys—							
N. Saskatchewan Irr. project	N. Sask., Clearwater, Raven and Red Deer rivers	3,538,760	1,400,000	....	....	....	
493 small private schemes	....	....	114,089	....	....	....	

WATERWAYS TREATY

Provision is made in Article 6 of the Waterways Treaty between Great Britain and the United States for the division between Canada and the United States of the waters of St. Mary and Milk rivers and their tributaries, in the state of Montana, and in the provinces of Alberta and Saskatchewan. This is done in such a manner as to recognize to some extent the prior appropriations from these streams in the respective countries, and to ensure approximately equal division of the waters, it being stipulated, however, that more water may be taken by one country from one stream and less from another without affecting the substantially equal division of the total flow.

The various details affecting the proper interpretation of Article 6 have been considered at a number of meetings of the International Joint Commission, held between 1915 and 1921. In the meantime and pending the issuance of a definite order it was necessary to provide for some method of dividing the waters of these streams, so that irrigation development might proceed without serious hindrance. On May 24, 1918, therefore, the commission issued an interim order describing in considerable detail the methods to be followed in measuring and apportioning the waters of these streams and their tributaries during the irrigation season of that year. This order was found to be satisfactory as a temporary expedient and was renewed in 1919, 1920, and 1921.

Under these interim orders the Reclamation officers of Canada and the United States have made measurements of stream-flow and apportioned the

waters as was found necessary from time to time. No serious difficulties were encountered, but it soon became apparent that no large irrigation development would be possible in either country until the proportion of stream-flow to be permanently assigned to each was definitely fixed. This was particularly the case in southern Alberta where surveys carried on by the Canadian Reclamation Service had demonstrated the feasibility of irrigating a considerable additional area of land by the utilization of all the available stream-flow and the conservation of flood-flow.

In September, 1921, meetings were held by the International Joint Commission at Chinook, Montana, and Lethbridge, Alberta, primarily for the purpose of giving locally interested persons an opportunity of presenting their views, and following these hearings the commission at its next regular meeting at Ottawa on October 4, 1921, gave an order which for all practical purposes may be regarded as finally settling the division of flow of these streams between the United States and Canada.

The measurement and apportionment of stream-flow were carried out during 1922 under the provisions of the order of October 4, just referred to. As in previous years, an engineer of the Reclamation Service acted in co-operation with an engineer of the United States Reclamation Service in this work and in the collection of data in connection therewith.

DRAINAGE

The year 1922-23 was the fourth of the operations of the Drainage Division of the Reclamation Service, investigating and planning drainage projects under the provisions of the Drainage Regulations.

The Regulations of the Dominion Government and the corresponding Reclamation Acts of the provinces of Alberta and Saskatchewan provide for the reclamation and disposition of wet or submerged Crown lands in these provinces briefly as follows:—

1 Sale of Dominion lands in a drainage project not exceeding 1,280 acres to individuals at a minimum price of $1 per acre under conditions of drainage.
2 Sale to the provinces of wet Dominion lands at a minimum price of $1 per acre to facilitate the construction, improvement and maintenance of public highways.
3 Sale to the provinces at a minimum price of $1 per acre of Dominion lands in drainage districts organized under the provisions of the Drainage Acts of the provinces.
4 Construction of drainage works by the Dominion Government where not less than one-half the area affected is vacant Dominion land.

During the season seventy-seven private drainage schemes under Part I of the Regulations were inspected and investigated in Alberta and Saskatchewan; under Part III, twelve drainage projects initiated by the provinces of Alberta and Saskatchewan were inspected; under Part IV, the investigation of one large scheme—the Athabaska project in Alberta, involving about 140 square miles of reclaimable land—was completed, while considerable progress was made towards completing the field investigations of the extensive Carrot River Triangle drainage project in Saskatchewan and Manitoba, which comprises an area aggregating about 1,400 square miles.

In the small projects carried out under the provisions of Part I of the Regulations the results have been very satisfactory both from the applicants' point of view and from that of the general good of the country. Every small drainage project successfully operated is a distinct benefit to the district in which it is situated, even though carried out at the entire expense of the

applicant. Individual farms become more profitable, and by making more land fit for homesteading, drainage brings about more compact settlement and improved conditions of living.

In the middle parts of the provinces where wet conditions have not been sufficient to seriously retard settlement, but still sufficient to cause considerable inconvenience to a number of farmers and to interfere with the traffic of the district, drainage districts have been formed under the jurisdiction of the provinces, and debentures issued to raise the necessary funds for constructional expenses. Other drainage districts are being petitioned for in many well settled areas.

Under Part III of the Regulations, twelve drainage districts have been formed in Alberta and twenty-two in Saskatchewan. In the north, however, scattered settlement precludes this method of operating, as the bulk of the land in any possible drainage district is still owned by the Dominion Government.

Under the provisions of Part IV of the Regulations, which covers drainage projects initiated by the Dominion Government, thirteen of the thirty-four large projects investigated have been reported feasible and recommended for construction. At present on account of the necessity for economy it has not been considered expedient for the Government to undertake the construction of any of these with the exception of the Waterhen Lake project. Estimates and plans and other necessary data are, however, on file in readiness for the commencement of construction at any time it is thought advisable.

The investigation of the largest project of all, the Carrot River Triangle drainage project, situated between the Saskatchewan and Carrot rivers, and comprising about 1,400 square miles of marsh lands, sloughs and lakes, presented many difficulties on account of the inaccessibility of the tract during the open season. On this account all the available parties of the Drainage Division were put on the work in the late fall in order to rush the surveys as soon as the "freeze-up" made it possible to penetrate the interior. This area promises to be exceedingly rich agricultural land if and when reclaimed. The large shallow lakes, bare of reeds, rushes and other vegetation, will be available for seeding to cultivated grasses as soon as unwatered, while the luxuriant and extensive grass lands that are now generally too wet to permit cutting will gradually be converted from hay lands into arable farm lands. Another field season will see the completion of all the necessary surveys and investigations.

The Waterhen Lake drainage project comprises about 13,900 acres of benefited land. Construction was commenced in the spring of 1921. In the fall of 1922 all the main canals and two of the bridges were completed. There remain to be constructed five bridges and the small laterals and culverts, which it is expected will be completed in the fall of 1923. The water of the lake was drained off by the end of September, 1922, and the bed is now quickly drying up. The parts bare of vegetation will be seeded immediately to timothy and the other parts brought under cultivation as soon as conditions are favourable.

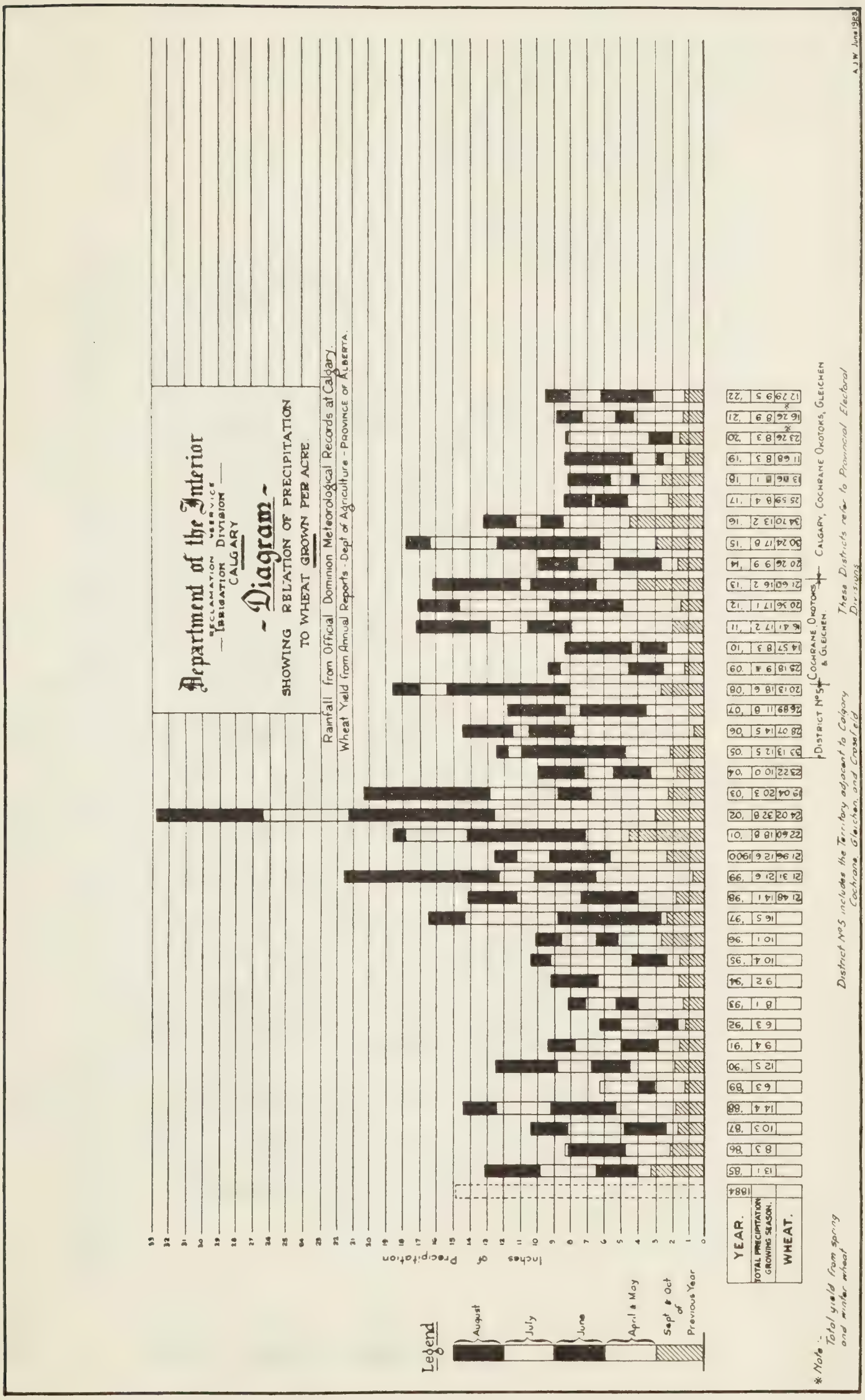
REPORT ON IRRIGATION SURVEYS AND INSPECTIONS FOR THE YEAR ENDED MARCH 31, 1923

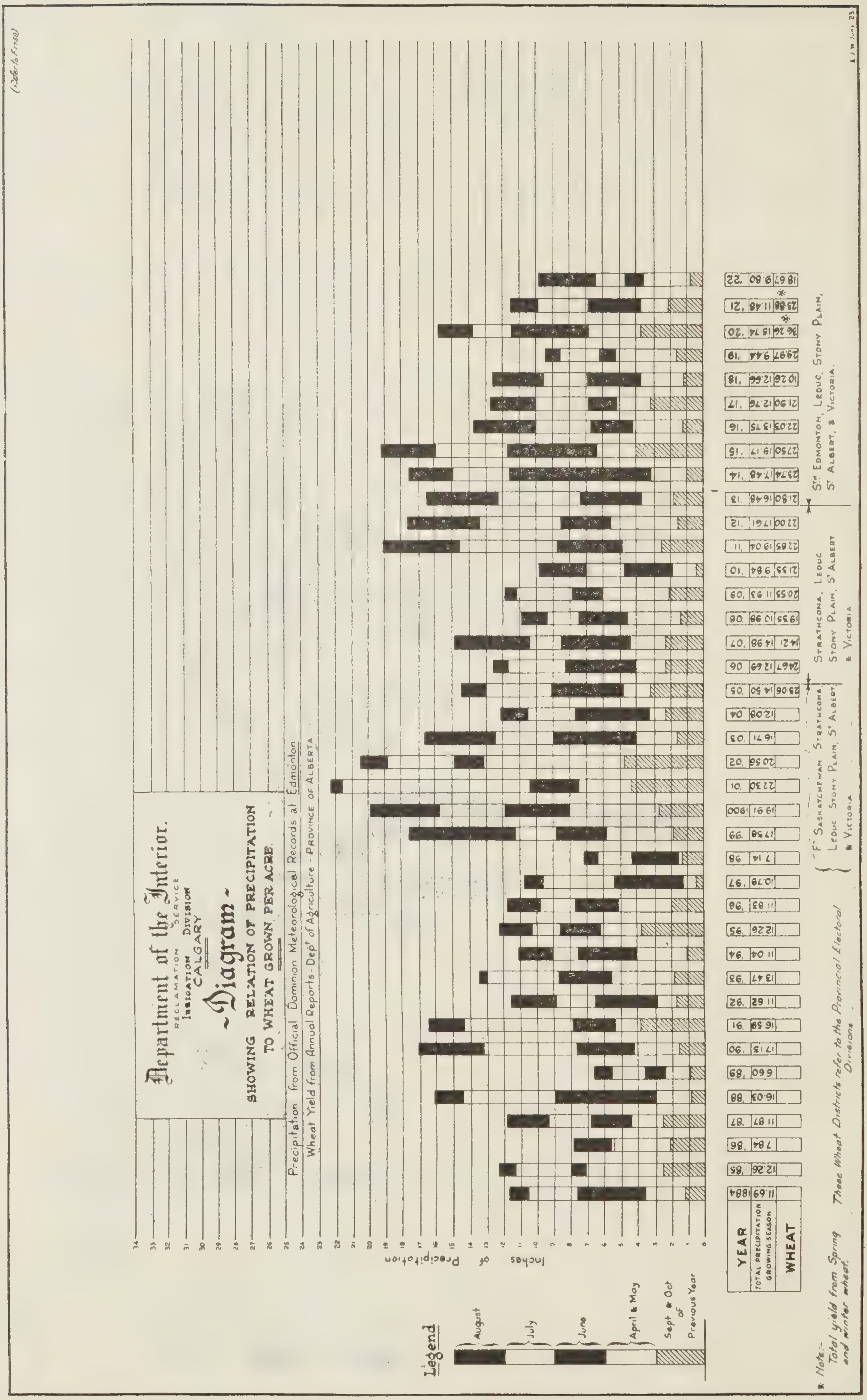
By V. Meek, Acting Commissioner of Irrigation and Chief Engineer

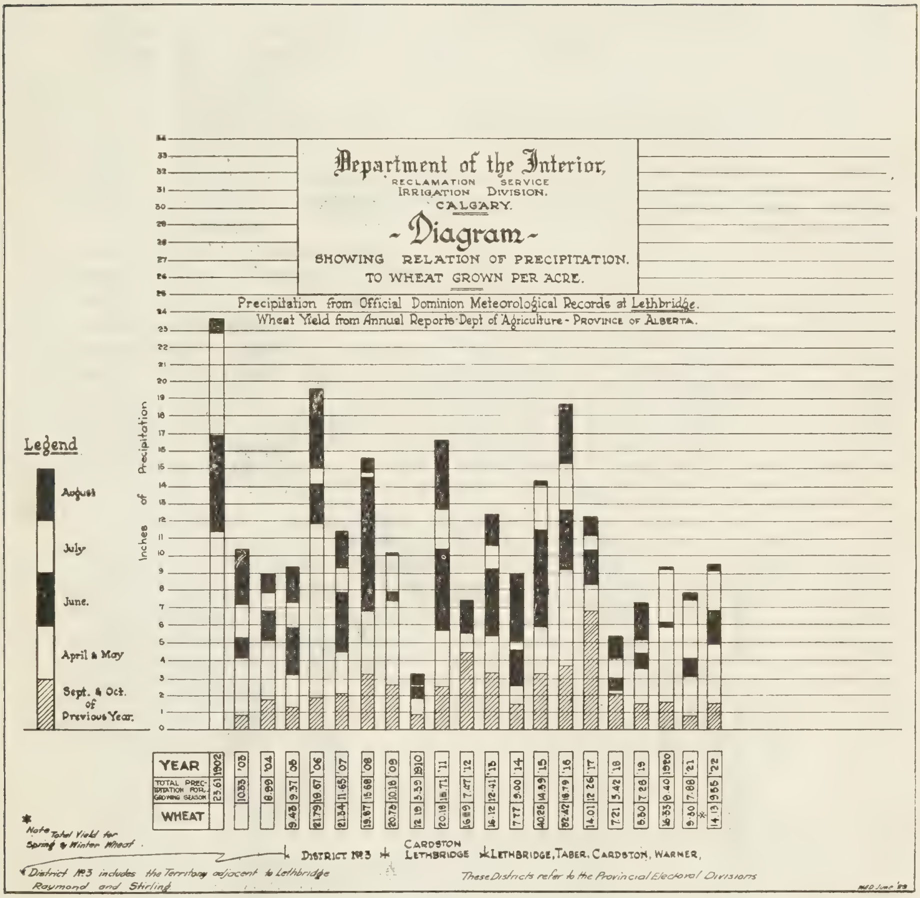
Following the procedure adopted in recent years, the report submitted herewith consists of a summary of the annual reports of the engineers in charge of the more important irrigation surveys and inspections.

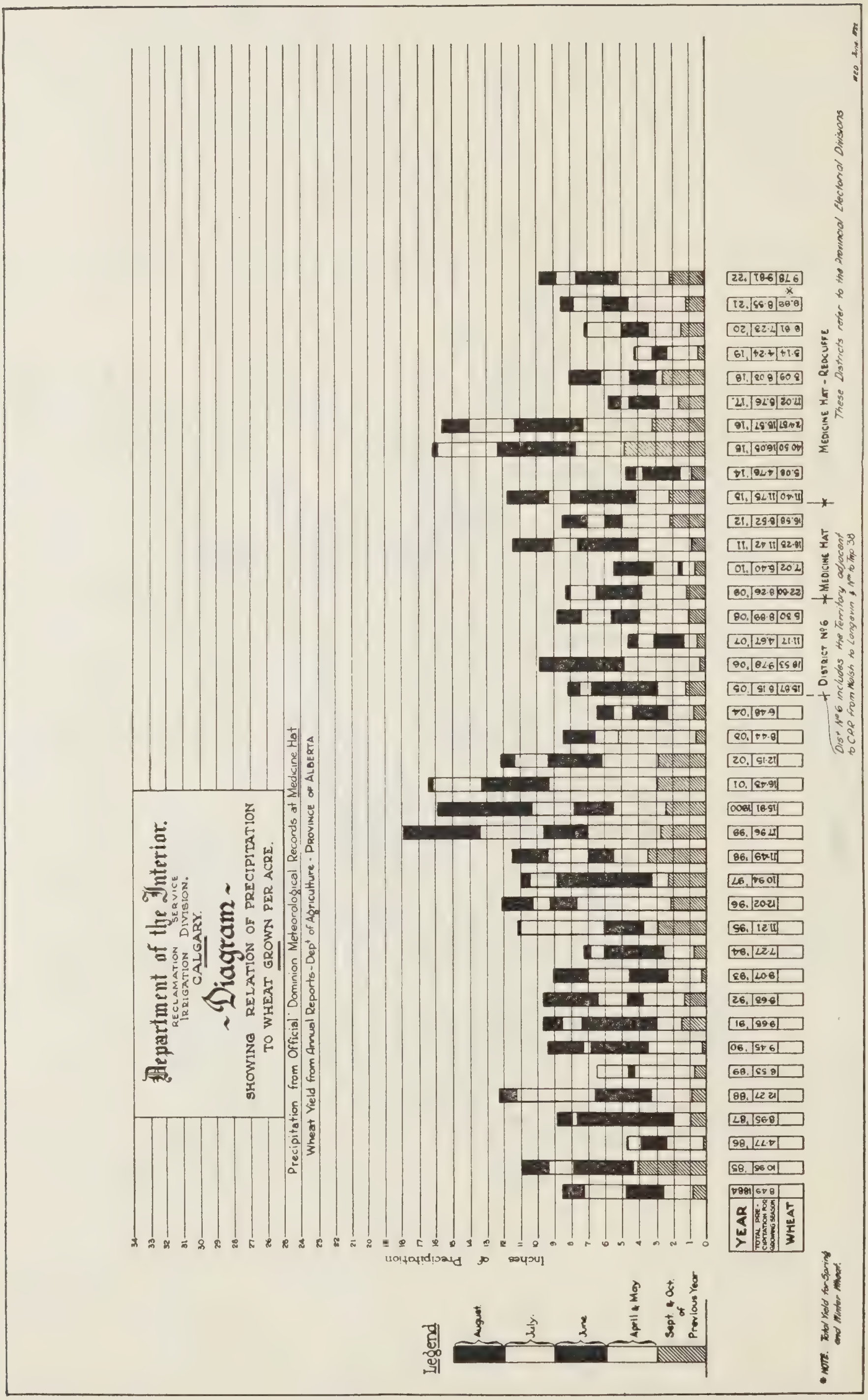
RELATION OF WHEAT YIELD TO RAINFALL

Graphs have again been prepared showing the rainfall during the growing season over the entire recorded periods at Calgary, Edmonton, Lethbridge


Department of the Interior
Reclamation Service
Irrigation Division
Calgary
- Diagram -
Showing Relation of Precipitation to Wheat Grown per Acre
Rainfall from Official Dominion Meteorological Records at Calgary.
Wheat Yield from Annual Reports - Dept of Agriculture - Province of Alberta.
Legend
August
July
June
April & May
Sept & Oct of Previous Year
Inches of Precipitation
YEAR.
TOTAL PRECIPITATION GROWING SEASON.
WHEAT.
District No 5 includes the Territory adjacent to Calgary Cochrane, Gleichen, and Crossfield
These Districts refer to Provincial Electoral Divisions
* Note:- Total yield from spring and winter wheat


(Refer to F1758)
Department of the Interior.
RECLAMATION SERVICE
IRRIGATION DIVISION
CALGARY
~Diagram~
SHOWING RELATION OF PRECIPITATION
TO WHEAT GROWN PER ACRE.
Precipitation from Official Dominion Meteorological Records at Edmonton
Wheat Yield from Annual Reports - Dep^t of Agriculture - PROVINCE OF ALBERTA
Inches of Precipitation
Legend
August
July
June
April & May
Sept & Oct of Previous Year
YEAR
TOTAL PRECIPITATION GROWING SEASON
WHEAT
1884 11.69
'85 12.26
'86 7.84
'87 11.87
'88 16.03
'89 6.60
'90 17.13
'91 16.59
'92 11.62
'93 13.47
'94 11.04
'95 12.26
'96 11.83
'97 10.79
'98 7.14
'99 17.58
1900 19.91
'01 22.30
'02 20.56
'03 16.71
'04 12.08
'05 14.50 23.06
'06 12.69 24.67
'07 14.98 14.21
'08 10.98 19.35
'09 11.93 20.55
'10 9.84 21.55
'11 19.04 22.85
'12 17.61 22.00
'13 16.48 21.80
'14 17.48 23.74
'15 19.17 27.50
'16 13.75 22.03
'17 12.76 21.90
'18 12.66 10.26
'19 9.44 29.97
'20 15.74 36.26 *
'21 11.48 23.88 *
'22 9.80 18.67
* Note:- Total yield from Spring and winter wheat.
These Wheat Districts refer to the Provincial Electoral Divisions
F^t Saskatchewan Strathcona, Leduc Stony Plain, S^t Albert, & Victoria
Strathcona, Leduc Stony Plain, S^t Albert & Victoria
S^th Edmonton, Leduc, Stony Plain, S^t Albert, & Victoria.
A J W June 23


Department of the Interior,
RECLAMATION SERVICE
IRRIGATION DIVISION.
CALGARY.
- Diagram -
SHOWING RELATION OF PRECIPITATION.
TO WHEAT GROWN PER ACRE.
Precipitation from Official Dominion Meteorological Records at Lethbridge.
Wheat Yield from Annual Reports-Dept of Agriculture - PROVINCE OF ALBERTA.
Inches of Precipitation
Legend
August
July
June.
April & May
Sept. & Oct. of Previous Year.
YEAR
TOTAL PRECIPITATION FOR GROWING SEASON
WHEAT
1902 23.61
'03 10.53
'04 8.99
'05 9.37 9.43
'06 19.67 21.79
'07 11.65 21.34
'08 15.68 19.87
'09 10.16 20.78
1910 3.39 12.19
'11 16.71 20.18
'12 7.47 16.89
'13 12.41 16.12
'14 9.00 7.77
'15 14.39 40.25
'16 18.79 32.42
'17 12.26 14.01
'18 5.42 7.21
'19 7.28 6.80
1920 9.40 16.33
'21 7.88 9.30
'22 9.55 14.13
* Note Total Yield for Spring & Winter Wheat
DISTRICT No 3
CARDSTON LETHBRIDGE
LETHBRIDGE, TABER, CARDSTON, WARNER,
District No 3 includes the Territory adjacent to Lethbridge Raymond and Stirling
These Districts refer to the Provincial Electoral Divisions


Department of the Interior.
Reclamation Service
Irrigation Division.
Calgary.
~Diagram~
Showing relation of precipitation to wheat grown per acre.
Precipitation from Official Dominion Meteorological Records at Medicine Hat
Wheat Yield from Annual Reports - Dep't of Agriculture - Province of Alberta
Legend
August
July
June
April & May
Sept & Oct. of Previous Year
Inches of Precipitation
YEAR
TOTAL PRECIPITATION FOR GROWING SEASON
WHEAT
District No 6
Medicine Hat
Medicine Hat - Redcliffe
These Districts refer to the Provincial Electoral Divisions
* NOTE. Total Yield for Spring and Winter Wheat.

and Medicine Hat. In order to give an idea of the relationship of wheat yield to rainfall, the average yield from the crop districts adjacent to these places has been given immediately below the rainfall, and affords an interesting study for those who hold the view that there are definite cycles of wet years. A perusal of the chart for Calgary indicates that the driest recorded period was that which has just terminated, i.e. 1917-22. The total precipitation during this six-year period was only 51·5 inches or an average of 8·58 inches, the highest being 9·5 and the lowest 8·1. The lowest previously recorded period was between 1891-96, the total for the six years being 53·5 inches, or an average of 8·91 inches, the highest being 10·1 and the lowest 6·3. It is also interesting to note that at the culmination of the previous dry period there followed a cycle of seven wet years—1897 to 1903—during which southern Alberta experienced the wettest year on record, viz. 1902, with a precipitation of 32·8 inches during the growing season. It has been assumed that the precipitation from November to March in each year, which falls in the form of snow, is negligible, and is considered of no value for crop growth, as it is either dissipated by Chinook winds or runs off the frozen ground into the nearest drainage channels.

The graphs for Calgary, Medicine Hat, and Lethbridge clearly indicate that these districts suffer from prolonged periods of insufficient rainfall, necessitating the practice of irrigation if agricultural operations are to be successfully carried on.

Temperature and soil conditions at the time of seeding, and the moisture carried over in the soil from the previous year have an important bearing on the wheat yield, and this is very clearly illustrated by the yield for 1920 on the graph of the Calgary district. Much of the August and September precipitation for 1919 was stored in the soil for the 1920 crop, and with very favourable spring conditions the crop had an excellent start with apparently sufficient moisture to take care of it until the July rains arrived. This explains the peculiar discrepancy in the yields for 1919 and 1920, when with the same total precipitation for the growing season the yields differed by 50 per cent.

ORGANIZATION

No change was made in the organization of the staff except a slight increase in the number employed, which was necessary to complete the detail work in connection with surveys for the various proposed irrigation projects. A total of 186 persons was employed in the following divisions:—

Office staff permanent	25
Office staff temporary	12
Field staff permanent	16
Field staff temporary	13
Seasonal temporary field employees	120
Total	186

WATER ADMINISTRATION

The primary purpose of this work is to ensure that water grants are not issued in excess of the quantities which may be expected under normal conditions of supply, and to define the rights in such a manner that future conflicting claims may be adjusted with the minimum friction.

The amount of current administrative work carried out during the year 1922 is roughly indicated by the following figures:—

—	December, 1921	December, 1922	Increase	Decrease
Licenses in good standing	783	830	47	....
Permits	26	29	3	....
Authorizations	237	323	86	....
Schemes under investigation	418	357	....	61
Cancellations	798	897	99	....
	2,262	2,436	235	61

New applications received during 1922 174

The official operations during the year were as follows:—

Applications filed	174
Authorizations issued	139
Licenses issued	72
Permits issued	11
Cancellations	99
Total	495

Water Administration Maps.—Each stage of progress in connection with any filing is indicated on special maps so that the appropriations in any area may be seen at a glance. There is a large amount of work in the preparation of each sheet and it can only be made piecemeal as the results of field surveys and investigations are reported. Eighty-seven maps have now been completed and twenty draft sheets are under compilation.

Water Studies.—The water studies undertaken during the year included the following:—

Proposed Highwood River Irrigation district from Highwood river.
Proposed Granum Irrigation district from Willow creek, or its tributaries.
Extension of proposed United district from Belly river.
Proposed Mountain View Irrigation district from Belly river.
Proposed South Macleod Irrigation district from Waterton river.
Irrigation development from Berry creek.
Medicine Hat Irrigation district from Ross creek, Bullshead creek and Sevenpersons creek.
Proposed Robsart-Vidora Irrigation district from Frenchman river.
Irrigation development from Battle creek.
Irrigation development from Sage creek.
Irrigation development from Manyberries creek.

Hydrometric Work. The Dominion Water Power Branch is now responsible for all the regular stream gauging for statistical and similar purposes, but officers of the Reclamation Service undertake the measurement of irrigation diversion ditches and miscellaneous measurements in connection with estimates for water supply to particular schemes. They are also responsible for intensive investigations, and the two branches co-operate in securing and exchanging records wherever practicable, with a view to economy of field time and expense. In the coming year it has been arranged to establish ten new stream stations and abandon nine old stations, where the records are sufficiently extensive. Winter measurements will be abandoned at eleven others.

Flood Discharge.—Some preliminary study has been given to the question of formulating a method of estimating the probable maximum flood to be expected at any point on a recorded stream, or on a stream for which there are no hydrometric records. Location and extent of drainage area are the principal factors involved and it is proposed to classify the various streams as follows:—

A Rocky mountains
B Upper foothills
C Lower foothills and Cypress hills
D Prairie

The "Maximum factor" or the ratio of maximum flow to the average flow is a good general guide to the character of a stream, and these values are being systematically worked up in relation to the average annual duration of flow and the maximum run-off per square mile corrected for a standard of 100 square miles of drainage area.

The object of these investigations is to secure closer estimates of stream flow for the design of spillways and other structures.

Representative values are indicated in the following table:—

—	A	B	C	D
Acre-feet per square mile	1,500	500	80	30
Yearly variation	50%	150%	200%	300%
Maximum factor	9	30	53	70
Maximum C.F.S. per square mile	18	21	6	3
Duration of mean flow in days	125	72	50	40

INSPECTION WORK

Special Inspection.—Domestic, Municipal, Industrial and Irrigation.

This work was carried on by five field engineers under the supervision of an office engineer and an assistant office engineer. The five inspection districts with the number of inspections carried out in each are tabulated below:—

District	Number of inspections made during season
East Cypress hills	82
West Cypress hills	149
Cardston	113
Alberta special inspections	89
Saskatchewan special inspections	60

There was a distinct falling-off in the number of new applications recorded in this fiscal year, the total number being 151 as against 232 for the previous year. This, however, did not reduce the work of the inspectors to any appreciable extent, there being 466 inspections made by the regular inspection staff in 1921 and 455 in 1922, the total number of inspections made in these two years was 552 and 493 respectively. The remainder were made by engineers of the branch regularly engaged on other than inspection work. The end of the field season found this work in all districts in a very satisfactory condition.

District Offices.—The two district offices at Lethbridge and Medicine Hat were maintained last season for the use and convenience of the district engineers and the public. The latter office was found to be of great value to the engineer in charge of the West Cypress Hills district and will prove even more valuable this coming season since a change in district boundaries brings Medicine Hat within easy reach of the engineer in charge of the East Cypress Hills district. The Lethbridge office was used almost exclusively by the engineer supervising construction work on the Lethbridge Northern and United Irrigation districts, it being too far east to prove of any practical value to the inspecting engineer in charge of the Cardston district. The latter engineer is very much in need of suitable office accommodation in a central location within his district, and it has been arranged to provide this for the coming year in one of the disused buildings of the old Royal Canadian Mounted Police Barracks at Macleod.

Watermasters.—Conditions of water supply are critical in certain portions of the three southernmost inspection districts, viz.:—East Cypress Hills, West Cypress Hills, and Cardston, and it has been found necessary to issue watermaster's warrants to the engineers in charge. The holders of these warrants are empowered to adopt measures for regulating diversions of water in settlement of any dispute or complaint which may arise from time to time.

Demonstration Work.—The crop yield per acre on the individual irrigation scheme is generally far below the yield which could be obtained by better methods of irrigating. The inspecting engineers visit these schemes from time to time in the execution of their regular duties, and it is now proposed to utilize their services for the purpose of interesting the irrigators on the smaller schemes in adopting more scientific methods of irrigation.

It is planned to operate one or two demonstration plots in each inspection district in 1924. These plots would be areas chosen on small schemes, and irrigated under the supervision of the district inspecting engineer for the purpose of demonstrating the increase in yield which follows the proper application of water.

Domestic Water Supplies.—The number of applications received for permission to divert water for domestic purposes was much the same as in previous years. The most frequent type of application is one for permission to impound the spring run-off from a coulee by means of an earth embankment with a natural or artificial spillway. Many illegal dams of this nature are in existence throughout the two provinces, but it is not the policy of the department to take the initiative in preventing these small illegal diversions, providing, of course, no other interests are adversely affected. In many instances, however, the owners of these schemes will at some future date find that other appropriators have filed prior rights on the same source of supply, and eventually the individuals constructing authorized schemes may invoke the aid of the department for the purpose of closing down the earlier schemes which have not been licensed. This is carefully explained to the owners of such schemes as come to our attention and they are advised to file applications in order to protect themselves, it being pointed out to them that the protection thus afforded is well worth the small expenditure in obtaining a license.

Municipal Water Consumption Data.—The collection of municipal water supply data, which was commenced by this branch in 1914, has been continued throughout the past year. The department is indebted to the various towns and cities for co-operation which has made this work possible. The records have been compiled in a manner similar to other years and are submitted in the following tables:—

Cities and Towns in the Province of Alberta—Daily record of Water Consumption in Imperial gallons for the year 1922

Month	Athabaska						Bassano					
	Population 450						Population 1,000					
	Daily Average for the month	Per Head for domestic purposes	Per Head for industrial purposes	Per Head for other purposes	Per Head for all purposes	Unaccounted for	Daily Average for the month	Per Head for domestic purposes	Per Head for industrial purposes	Per Head for other purposes	Per Head for all purposes	Unaccounted for
January	9,090	....	....	....	20·2	....	96,129	....	....	....	96·1	....
February	10,380	....	....	....	23·1	....	105,178	....	....	....	105·2	....
March	17,090	....	....	....	37·9	....	108,742	....	....	....	108·7	....
April	17,750	....	....	....	39·4	....	118,330	....	....	....	118·3	....
May	11,550	....	....	....	25·6	....	124,516	....	....	....	124·5	....
June	17,550	....	....	....	39·0	....	144,833	....	....	....	144·8	....
July	16,700	....	....	....	37·1	....	197,833	....	....	....	197·8	....
August	11,230	....	....	....	25·0	....	172,097	....	....	....	172·1	....
September	12,900	....	....	....	28·7	....	147,833	....	....	....	147·8	....
October	10,850	....	....	....	24·2	....	141,613	....	....	....	141·6	....
November	8,620	....	....	....	19·2	....	137,000	....	....	....	137·0	....
December	6,550	....	....	....	14·4	....	134,290	....	....	....	134·3	....
Average for the year	12,520	....	....	....	27·8	....	135,700	....	....	....	135·7	....

Cities and Towns in the Province of Alberta—Daily record of water consumption in Imperial gallons for the year 1922—Continued

Month	Edmonton, Population 60,000: Daily Average for the month	Per Head for domestic purposes	Per Head for industrial purposes	Per Head for other purposes	Per Head for all purposes	Unaccounted for	Lethbridge, Population 11,000: Daily Average for the month	Per Head for domestic purposes	Per Head for industrial purposes	Per Head for other purposes	Per Head for all purposes	Unaccounted for
January	6,431,420	60·4	25·6	21·2	107·2	....	1,500,741	103·3	33·9	....	137·2	....
February	6,808,143	64·4	23·8	25·3	113·5	....	1,641,964	109·0	40·3	....	149·3	....
March	6,851,839	61·9	26·0	26·3	114·2	....	1,553,483	104·1	37·1	....	141·2	....
April	6,613,333	64·0	27·2	20·0	110·2	....	1,570,066	107·1	35·6	....	142·7	....
May	6,922,484	62·4	29·6	23·4	115·4	....	1,628,677	116·5	31·6	....	148·1	....
June	7,148,000	64·5	30·5	24·1	119·1	....	1,830,766	129·0	34·8	2·6	166·4	....
July	6,863,839	61·4	29·7	23·3	114·4	....	1,593,548	105·9	37·0	2·0	144·9	....
August	6,896,936	61·9	24·3	28·7	114·9	....	1,906,193	139·8	29·9	3·6	173·3	....
September	6,685,067	62·3	21·9	27·2	111·4	....	1,700,466	113·4	39·9	1·3	154·6	....
October	6,380,839	60·3	19·4	26·6	106·3	....	1,411,290	97·8	30·5	....	128·3	....
November	6,131,300	61·6	19·7	20·9	102·2	....	1,402,700	100·8	28·2	....	129·0	....
December	6,305,839	61·3	21·5	22·3	105·1	....	1,396,709	103·1	23·7	....	126·8	....
Average for the year	6,669,920	62·2	24·9	24·1	111·1	....	1,595,383	110·8	33·5	....	145·1	....

Month	Medicine Hat, Population 10,000: Daily Average for the month	Per Head for domestic purposes	Per Head for industrial purposes	Per Head for other purposes	Per Head for all purposes	Unaccounted for	Redcliff, Population 1,200: Daily Average for the month	Per Head for domestic purposes	Per Head for industrial purposes	Per Head for other purposes	Per Head for all purposes	Unaccounted for
January	1,590,322	....	....	....	159·0	....	104,419	80·0	7·0	....	87·0	....
February	1,671,000	....	....	....	167·1	....	94,777	70·6	8·4	....	79·0	....
March	1,410,000	....	....	....	141·0	....	102,637	78·1	7·4	....	85·5	....
April	1,262,667	....	....	....	126·3	....	103,125	78·1	7·8	....	85·9	....
May	1,571,613	....	....	....	157·2	....	154,734	119·9	9·0	....	128·9	....
June	2,435,667	....	....	....	243·6	....	236,400	186·1	10·9	....	197·0	....
July	2,500,000	....	....	....	250·0	....	223,548	176·9	9·4	....	186·3	....
August	2,424,839	....	....	....	242·5	....	106,452	88·7	....	....	88·7	....
September	1,879,333	....	....	....	187·9	....	104,948	79·5	8·0	....	87·5	....
October	1,905,484	....	....	....	190·5	....	106,895	80·5	8·5	....	89·0	....
November	1,901,333	....	....	....	190·1	....	102,117	76·2	9·1	....	85·3	....
December	1,999,000	....	....	....	199·9	....	81,258	60·2	7·4	....	67·6	....
Average for the year	1,879,271	....	....	....	187·9	....	126,777	97·9	7·8	....	105·6	....

Cities and Towns in the Province of Saskatchewan—Daily record of water consumption in Imperial gallons for year 1922

Month	Estevan, Population 2,300: Daily Average for the month	Per Head for domestic purposes	Per Head for industrial purposes	Per Head for other purposes	Per Head for all purposes	Unaccounted for	Kamsack, Population 275: Daily Average for the month	Per Head for domestic purposes	Per Head for industrial purposes	Per Head for other purposes	Per Head for all purposes	Unaccounted for
January	50,677	9·1	7·1	6·0	22·2	....	206,933	25·1	727·0	....	752·1	....
February	40,893	7·2	5·7	4·8	17·7	....	221,904	65·0	743·0	....	808·0	....
March	37,549	6·7	5·2	4·4	16·3	....	195,458	65·6	646·0	....	711·6	....
April	38,667	7·8	5·1	4·0	16·9	....	172,813	51·6	576·0	....	627·6	....
May	39,355	7·9	5·1	4·1	17·1	....	182,103	50·4	612·0	....	662·4	....
June	50,867	10·2	6·6	5·3	22·1	....	158,350	43·4	534·0	....	577·4	....
July	43,194	10·0	7·3	1·4	18·7	....	142,767	41·0	477·0	....	518·0	....
August	47,774	11·2	8·1	1·5	20·8	....	168,729	50·4	563·0	....	613·4	....
September	38,233	8·9	6·5	1·2	16·6	....	223,216	51·4	761·0	....	812·4	....
October	34,871	7·7	6·7	0·8	15·2	....	242,406	46·9	836·0	....	882·9	....
November	35,000	7·7	6·7	0·8	15·2	....	256,450	54·6	878·0	....	932·6	....
December	36,839	8·1	7·0	0·9	16·8	....	271,935	58·7	930·0	....	988·7	....
Average for the year	41,159	8·5	6·4	2·9	17·9	....	203,589	50·3	690·2	....	740·6	.....

Cities and Towns in the Province of Saskatchewan—Daily record of water consumption in Imperial gallons for the year 1922—Continued

Month	Kindersley — Population 1,000 — Daily Average for the month	Per Head for domestic purposes	Per Head for industrial purposes	Per Head for other purposes	Per Head for all purposes	Unaccounted for
January	20,101	8·3	11·8	....	20·1	....
February	23,286	8·6	14·7	....	23·3	....
March	20,373	9·7	10·7	....	20·4	....
April	27,150	11·1	16·0	....	27·1	....
May	22,905	8·7	14·2	....	22·9	....
June	26,120	10·1	16·0	....	26·1	....
July	32,440	10·8	21·6	....	32·4	....
August	22,634	11·1	11·5	....	22·6	....
September	24,190	10·7	13·5	....	24·2	....
October	16,665	10·8	5·9	....	16·7	....
November	15,415	10·4	5·0	....	15·4	....
December	17,402	10·9	6·5	....	17·4	....
Average for the year	22,390	10·1	12·3	....	22·4	....

Month	Moose Jaw — Population 20,000 — Daily Average for the month	Per Head for domestic purposes	Per Head for industrial purposes	Per Head for other purposes	Per Head for all purposes	Unaccounted for
January	798,000	31·4	8·5	....	39·9	....
February	817,000	32·9	7·9	....	40·8	....
March	821,000	32·8	8·2	....	41·0	....
April	762,000	30·1	8·0	....	38·1	....
May	742,000	28·4	8·7	....	37·1	....
June	924,000	35·1	11·1	....	46·2	....
July	917,000	32·1	13·7	....	45·8	....
August	965,000	39·1	9·2	....	48·3	....
September	943,000	38·8	8·3	....	47·1	....
October	965,000	41·9	6·3	....	48·2	....
November	949,000	38·3	9·2	....	47·5	....
December	900,000	36·2	8·8	....	45·0	....
Average for the year	875,250	34·8	9·0	....	43·8	....

Month	North Battleford — Population 4,100 — Daily Average for the month	Per Head for domestic purposes	Per Head for industrial purposes	Per Head for other purposes	Per Head for all purposes	Unaccounted for
January	123,161	12·3	0·7	2·5	30·1	14·6
February	121,739	11·5	....	3·6	29·7	14·6
March	153,433	10·1	1·0	18·0	37·5	8·4
April	154,430	10·3	5·7	1·3	37·6	20·3
May	137,600	11·4	0·3	2·6	33·6	19·3
June	159,250	10·9	....	6·7	38·8	21·2
July	169,500	12·0	6·6	3·7	41·4	19·1
August	139,600	11·6	3·9	5·2	34·0	13·3
September	135,390	10·4	3·2	3·0	33·0	16·4
October	133,000	10·4	4·4	1·5	32·4	16·1
November	132,500	10·2	4·3	0·1	32·3	17·7
December	117,000	10·5	4·2	3·3	28·4	10·4
Average for the year	139,717	11·0	2·8	4·3	34·1	15·9

Month	Prince Albert — Population 7,500 — Daily Average for the month	Per Head for domestic purposes	Per Head for industrial purposes	Per Head for other purposes	Per Head for all purposes	Unaccounted for
January	532,500	19·6	30·0	0·2	71·1	21·3
February	510,082	23·8	29·1	0·5	68·0	14·6
March	514,919	21·4	26·4	....	68·6	20·8
April	468,450	22·1	24·1	0·1	62·6	16·3
May	465,729	18·5	19·2	1·0	62·1	23·4
June	573,000	20·1	26·3	2·3	76·2	27·5
July	584,661	18·2	25·3	3·7	77·9	30·7
August	535,032	20·5	30·6	2·5	71·4	17·8
September	511,130	19·6	29·6	5·6	68·1	13·3
October	490,841	18·3	26·0	4·1	65·5	17·1
November	506,056	21·7	30·9	1·5	67·5	13·4
December	570,138	21·4	28·1	1·7	76·0	24·8
Average for the year	521,878	20·4	23·2	1·9	69·6	20·1

Month	Regina — Population 35,000 — Daily Average for the month	Per Head for domestic purposes	Per Head for industrial purposes	Per Head for other purposes	Per Head for all purposes	Unaccounted for
January	2,463,408	54·3	13·2	2·8	70·3	....
February	2,508,156	57·3	11·3	3·2	71·8	....
March	2,668,670	63·4	9·7	3·1	76·2	....
April	2,620,122	63·6	6·5	4·7	74·8	....
May	2,432,000	59·1	7·8	2·5	69·4	....
June	2,407,668	57·1	8·9	2·7	68·7	....
July	2,479,883	56·0	12·6	2·2	70·8	....
August	2,694,461	58·2	17·2	1·8	77·2	....
September	2,764,445	57·7	19·4	1·8	78·9	....
October	2,756,691	60·3	16·8	1·6	78·7	....
November	2,746,118	59·4	17·2	1·7	78·3	....
December	2,760,065	66·5	10·6	1·8	78·9	....
Average for the year	2,608,474	59·2	12·6	2·5	74·5	....

Month	Saskatoon — Population 27,000* — Daily Average for the month	Per Head for domestic purposes	Per Head for industrial purposes	Per Head for other purposes	Per Head for all purposes	Unaccounted for
January	1,891,096	33·9	17·8	0·8	70·1	17·6
February	1,928,785	34·5	18·2	0·9	71·6	18·0
March	2,006,129	35·9	18·8	0·9	74·2	18·6
April	2,006,129	29·7	21·0	1·2	74·2	22·3
May	2,109,677	29·8	21·1	1·2	74·6	22·5
June	2,337,333	36·6	24·4	1·4	86·4	26·0
July	2,504,516	29·5	34·1	2·9	92·9	26·4
August	2,283,225	28·1	32·3	2·8	88·2	25·0
September	2,166,666	25·5	29·5	2·5	80·3	22·8
October	2,126,129	30·5	22·8	1·3	78·7	24·1
November	2,032,666	29·0	21·8	1·3	75·2	23·1
December	1,997,806	28·5	21·4	1·3	73·9	22·7
Average for the year	2,115,846	31·0	23·6	1·5	78·4	22·4

*Includes Town of Sutherland.

Cities and Towns in the Province of Saskatchewan—Daily record of water consumption in Imperial gallons for year 1922—Concluded

Month	Weyburn — Population 3,200: Daily Average for the month	Per Head for domestic purposes	Per Head for industrial purposes	Per Head for other purposes	Per Head for all purposes	Unaccounted for
January	156,209	...	...	...	48·8	...
February	174,817	...	...	...	54·6	...
March	200,350	...	...	...	62·6	...
April	184,345	...	...	...	57·6	...
May	204,355	...	...	...	63·8	...
June	221,883	...	...	...	69·4	...
July	219,766	...	...	...	68·8	...
August	237,782	...	...	...	74·5	...
September	221,274	...	...	...	69·3	...
October	220,710	...	...	...	69·1	...
November	218,221	...	...	...	68·4	...
December	210,008	...	...	...	65·7	...
Average for the year	205,810	...	...	...	64·4	...

Cities and Towns in the Province of Alberta—Record of average daily water consumption in Imperial gallons for the years 1915-22

Average for the Year	Per Head Domestic	Per Head Industrial	Per Head other Purposes	Per Head all Purposes	Unaccounted for	Per Head Domestic	Per Head Industrial	Per Head other Purposes	Per Head all Purposes	Unaccounted for
	Edmonton					Lethbridge				
1915	46·0	31·0	3·0	80·0	...	81·4	32·2	1·5	115·1	...
1916	52·5	20·7	5·7	78·9	...	116·0	41·3	0·7	158·0	...
1917	56·3	25·0	9·7	91·0	...	95·0	55·0	...	150·0	...
1918	58·0	26·2	10·1	94·3	...	102·2	44·7	3·0	149·9	...
1919	56·7	24·6	9·7	91·7	...	78·1	26·9	...	107·3	...
1920	54·7	23·4	16·2	94·3	...	91·8	35·1	†6·8	129·1	...
1921	54·6	23·4	16·8	94·8	...	94·2	27·8	1·4	123·4	...
1922	62·2	24·9	24·1	111·1	...	110·8	33·5	...	145·1	...
	Bassano					Carmangay				
1915	6·5	60·2	...	66·7	...	41·9	...	2·0	43·9	...
1916	...	...	...	...	...	32·6	...	...	32·6	...
1917	17·9	154·3	95·4	267·6	...	31·3	...	...	31·3	...
1918	...	...	...	211·0	...	29·8	...	1·0	30·8	...
1919	...	...	...	194·7	...	32·5	...	1·2	33·7	...
1920	...	...	...	158·9	...	26·2	...	*3·4	30·3	...
1921	...	...	...	137·8	...	...	...	...	...	...
1922	...	...	...	135·7	...	...	...	...	...	...
	Medicine Hat					Redcliffe				
1915	181·0	28·0	15·0	224·0	...	31·1	6·8	...	37·9	...
1916	214·0	...	...	214·0	...	36·8	22·1	1·0	59·9	...
1917	257·0	...	...	257·0	...	42·5	30·3	...	72·8	...
1918	...	...	...	264·0	...	66·4	22·4	...	88·8	...
1919	...	...	...	234·0	...	79·1	13·7	...	92·8	...
1920	...	...	...	206·8	...	67·9	16·2	...	84·2	...
1921	...	...	...	175·3	...	65·7	9·6	0·46	75·7	...
1922	...	...	...	187·9	...	97·9	7·8	...	105·6	...
	Athabaska									
1915	...					14·3	...	...	14·3	...
1916	...					10·9	...	...	10·9	...
1917	...					24·0	...	...	24·0	...
1918	...					27·6	...	...	27·6	...
1919	...					26·1	...	...	26·1	...
1920	...					44·3	...	...	44·3	...
1921	...					33·3	...	...	33·3	...
1922	...					...	...	...	27·8	...

† 4 months. * 7 months

Cities and Towns in the Province of Saskatchewan—Record of average daily water consumption in Imperial gallons for the years 1915-22

Average for the Year	Per Head Domestic	Per Head Industrial	Per Head other Purposes	Per Head all Purposes	Unaccounted for	Per Head Domestic	Per Head Industrial	Per Head other Purposes	Per Head all Purposes	Unaccounted for
	Regina					Saskatoon				
1915..........	55·0	7·5	0·1	62·6	....	21·6	13·9	2·2	45·6	7·9
1916..........	66·1	7·8	....	68·9	....	21·0	15·4	1·9	52·6	14·3
1917..........	59·2	12·6	0·3	72·1	....	24·4	15·6	5·8	66·4	20·6
1918..........	56·9	11·1	0·1	68·1	....	27·1	17·2	2·4	63·1	16·4
1919..........	42·8	8·3	....	51·2	....	28·0	16·3	1·9	64·1	17·9
1920..........	48·9	9·1	*0·9	58·8	....	29·4	14·3	6·1	74·1	24·4
1921..........	49·6	10·1	2·1	62·5	0·74	29·5	20·3	1·0	72·0	21·2
1922..........	59·2	12·6	2·5	74·5	....	31·0	23·6	1·5	78·4	22·4
	Moose Jaw					North Battleford				
1915..........	24·1	4·6	....	28·7	....	6·6	1·3	2·7	14·8	4·2
1916..........	35·2	12·3	....	47·5	....	9·5	2·0	4·9	22·7	6·3
1917..........	45·8	13·1	....	58·9	....	10·2	2·2	4·0	23·1	6·7
1918..........	31·6	15·4	....	47·0	....	10·0	4·8	3·0	26·3	8·5
1919..........	24·8	15·1	....	39·9	....	11·5	1·6	4·4	29·7	12·2
1920..........	24·5	14·5	....	39·1	....	11·3	5·8	5·9	34·0	10·9
1921..........	30·9	3·9	6·2	41·0	....	9·7	2·8	2·9	26·7	11·3
1922..........	34·8	9·0	....	43·8	....	11·0	2·8	4·3	34·1	15·9
	Weyburn					Estevan				
1915..........	17·4	....	0·4	17·8	....	9·5	7·1	1·5	18·1	....
1916..........	16·9	....	0·3	17·2	....	8·2	5·7	1·0	14·9	....
1917..........	30·1	....	....	30·1	....	9·7	5·5	4·3	19·5	....
1918..........	26·4	....	....	26·4	....	9·3	0·7	7·2	17·2	....
1919..........	25·5	....	....	25·5	....	9·6	2·9	....	12·5	....
1920..........	30·2	....	....	30·2	....	9·3	4·4	....	13·7	....
1921..........	27·1	....	....	27·1	....	6·1	4·7	2·0	12·8	....
1922..........	....	....	....	64·4	....	8·5	6·4	2·9	17·9	....
	Kamsack					Kindersley				
1915..........	....	....	....	....	....	4·9	8·4	1·6	14·9	....
1916..........	....	....	....	....	....	5·5	26·8	....	32·3	....
1917..........	....	....	....	....	....	5·8	44·4	....	50·2	....
1918..........	31·6	66·3	....	97·9	....	6·0	8·9	....	14·9	....
1919..........	....	....	....	....	....	7·8	....	....	7·8	....
1920..........	....	....	....	....	....	6·9	17·5	....	21·5	....
1921..........	50·4	724·9	....	775·3	....	8·5	11·0	....	19·5	....
1922..........	50·3	690·2	....	740·6	....	10·1	12·3	....	22·4	....
						Prince Albert				
1921..........	....	....	....	....	....	....	....	....	83·0	....
1922..........	....	....	....	....	....	20·4	23·2	1·9	69·6	20·1

*10 months.

EAST CYPRESS HILLS DISTRICT

M. H. French was again in charge of this district. It is situated in the southwest corner of the province of Saskatchewan, lying south of township 17, and west of range 11, west of the 3rd meridian.

In addition to the inspection work in his district, Mr. French, being the only qualified Dominion land surveyor on the field staff, made whatever right of way surveys were required in the two provinces of Alberta and Saskatchewan. He also selected the Maple Creek alkali test plots, prepared, seeded, and fenced them, and did all the work in connection with these plots throughout the season. Mr. French sets forth in detail his observations on these plots in a separate report.

Several days were spent by him in the field on a reconnaissance of the Sage creek drainage basin during the latter part of August, with a view to investigating the possibilities of reservoir sites. Several were located and roughly outlined. It is the intention next season to survey two or three of the less expensive sites,

and to obtain spring flood records of Sage creek in order to estimate more accurately the average annual water supply.

The following extracts from Mr. French's annual report are of interest:—

"The crops throughout the district were fair. Some sections were favoured with large yields, while no portion suffered a total failure. I doubt whether any government seed or feed will be required this coming season in the Maple Creek district. The financial condition of the farmers is somewhat improved, partly because they are eliminating all hired help except what is absolutely necessary, and partly because more and more of them are going into mixed farming.

"Regarding the status of irrigation in the Cypress Hills district, a gradual improvement in the past twelve years in the methods of irrigating and of general interest in the subject can undoubtedly be noticed. As, however, many of the irrigation schemes are merely operated as sidelines by their owners, whose time and energies are largely diverted into other channels, there is difficulty in getting better methods adopted. The idea now being carried out of concentrating upon a few schemes and by field demonstration, inducing a few irrigators to make more use of their water, should be productive of tangible results."

WEST CYPRESS HILLS DISTRICT

C. M. Moore again had charge of this district. It is situated in the southeastern corner of the province of Alberta, bounded on the north by township 17 and on the west by range 17, west of the 4th meridian.

This district is located in one of the driest portions of the two provinces, and speaking generally, has not produced a paying crop since 1916. The western end of the Cypress hills extends well into the district and there are innumerable streams draining this range in all directions. The water supply is, however, meagre, uncertain and dependent almost entirely on the winter snowfall. The run-off occurs during a few weeks in the spring. Many of the streams are now, or are fast becoming, fully appropriated, and for this reason the large number of new applications received as a consequence of the failure of dry farming in the district, are difficult to deal with.

Mr. Moore spent the latter part of March and a part of April collecting early run-off data on certain small streams southwest of Medicine Hat, for which there were no run-off records available, and upon which applications for water rights had been filed. The latter part of April and the first week in May were devoted to field-work in connection with a proposed amendment of the Medicine Hat Eastern Irrigation project.

Mr. Moore in his annual report comments on conditions in his district as follows:—

"Throughout the year inspection work was largely confined to schemes which have not yet been licensed. On account of the increased demand for water for irrigation purposes, following the recent years of insufficient precipitation, very careful inspection of the water available has been necessary. The catchment area in each drainage basin must be defined and a careful estimate made of the average annual run-off available, taking into consideration any knowledge acquired of local conditions. Owing to the pressure of this work, no opportunity was afforded to visit licensed schemes for the purpose of assisting the irrigators in developing their projects.

"Generally speaking, a new applicant is not familiar with the method of constructing irrigation works and it is desirable for the inspecting engineer to visit and advise him as his work progresses. During the past season close touch was maintained with all owners while they were constructing their works, and they were visited from time to time and given any assistance required.

"Recently completed studies indicate that there will be water available for a few additional applicants on some of the streams in the Pakowki Lake drainage basin. Consequently a number of applicants have been permitted to proceed with their schemes during the past year. These schemes entail very small outlays of cash, and will afford a flood irrigation to cultivated lands on which the owners intend to sow grain and a small acreage of alfalfa."

CARDSTON DISTRICT

This district was again in charge of Wm. Wotherspoon. It comprises that portion of southern Alberta lying south of township 17, and west of range 16, west of 4th meridian.

The bulk of the inspection work in this district lies along its western side in the foothill country, where stock-raising is the principal industry. For this reason the most of irrigation schemes are devoted entirely to the raising of fodder crops.

Mr. Wotherspoon, in his annual report, comments briefly on general conditions in the district in so far as his inspection work is concerned as follows:—

"On authorized schemes the progress made with construction work has in most cases been poor. The majority of the applicants not being in a position to employ extra labour on the works, have difficulty in making rapid progress, as their time is fully taken up on routine farm work."

SPECIAL INSPECTIONS—ALBERTA DISTRICT

This district was again in charge of F. R. Burfield. It comprises all that portion of the province of Alberta lying north of township 16. The inspector is provided with a Ford truck for transportation purposes.

Last season the inspection work in the north of the province was carried out by the drainage engineer, D. Whittaker, whose work lay in that part of the province. This afforded a considerable saving in time and expense since—although the schemes in the north are few in number—they are widely scattered and difficult for the inspecting engineer to reach. Mr. Whittaker made eleven irrigation inspections in this district and one in the Saskatchewan Special Inspection district.

It is interesting to note that the greater part of the work last season was in connection with irrigation applications whereas a few years ago the major portion of the inspection work was on schemes for municipal, industrial and other purposes.

Some of the more interesting features of Mr. Burfield's annual report are quoted below:—

"As regards future irrigation development the district seems to divide naturally into two parts. One of these is the Bow River drainage basin. In this there are now three very large schemes which divert water from the Bow river, and several others, either new schemes or extensions of older ones, which are sufficiently advanced to hold reservations of water against the stream or its tributaries. As a consequence of these heavy appropriations, the period of time in which there is sufficient flow for further diversions is so reduced that the full duty of water cannot be beneficially applied. This condition will also seriously affect storage schemes on the smaller tributaries inasmuch as their flood flow normally occurs at times when their contribution is needed to meet appropriations already made on the main stream.

"It is worthy of note in regard to the schemes in the foothills, that the testimony of farmers appears unanimous viz.:—that less water is available in the creeks and from the springs than in the past, even in the dry years of the early nineties.

"The most important area in the remainder of the district is the drainage basin of the Red Deer river; so far no large appropriations have been made against this stream. It is possible for the inspecting engineer while on the ground to make a decision as to whether water is available, or can be made available by storage when required. The Red Deer itself has a flat gradient, and all diversions from it have taken the form of pumping schemes.

"The remainder of the district, apart from what is served by the large irrigation projects, lies outside the semi-arid area, and the schemes are widely scattered.

"As regards the licensed schemes, good work is being done on parts of the larger schemes and the area under irrigation is being increased."

SPECIAL INSPECTIONS—SASKATCHEWAN

This district was again in charge of J. E. Jaffary. It comprises the whole of the province of Saskatchewan, with the exception of a portion in the southwest corner, bounded on the north by township 17 and on the east by range 11, west 3rd meridian.

The inspection work in this district is very widely scattered, thus it cannot be carried out with much regard to economy either in time or expense. Most of the inspections are for domestic and industrial (railway water supply) schemes. Speaking generally, the supply available in natural waterways, lakes, etc., is a meagre one and this accounts for the large number of domestic schemes in the

province. For the most part, this district lies outside of the semi-arid region, and from an agricultural standpoint does not suffer from lack of moisture to the same extent as in the other inspection districts west of it. For this reason there are not very many irrigation schemes or applications for water rights for this purpose, and those which are in existence are widely scattered.

In the following extracts from Mr. Jaffary's report he outlines in a general way the conditions peculiar to the inspection work in his district:—

"As in previous years, the majority of inspections comprised industrial and domestic schemes, but a considerable number of irrigation applications also were filed. More attention is being given to irrigation by farmers, and numerous enquiries were made regarding irrigation schemes. A considerable number of inspections were made in connection with applications for rights on mineral salt lakes in so far as the Irrigation Act applied. These have been filed under the Alkali Mining Regulations and should become a commercial enterprise in the future.

"The Provincial Government has made a large number of applications for domestic rights on behalf of municipal districts for the domestic use of the settlers in the community. In many districts this is their only source of supply and water is hauled in tanks for miles around by settlers who are unable to secure an adequate supply from wells.

"Out of seven inspections made of pumping schemes during the season, I found all but one applicant enthusiastic over their plants, and this one farmer has more or less abandoned his place on account of having outside interests. Had he paid more attention to farming, it is more than probable that good results could have been attained here also. Several new pumping schemes were laid out for applicants during the season."

Large Irrigation Projects

CANADIAN PACIFIC RAILWAY COMPANY'S IRRIGATION PROJECTS

Western Section—

The gross area of this project is approximately 1,000,000 acres, of which 218,980 acres are classified irrigable. The project has now been in operation for fifteen years, water having been first diverted for a small area in the Gleichen district in 1907.

The company has continued its reconstruction and re-conditioning policy in connection with canals and structures, and during the past year has re-conditioned 359 structures. This work included bankgates, headgates, delivery gates, drops, bridges, and culverts. In addition 600 linear feet of ground flume, and 960 feet of trestle flume were re-conditioned.

Under the heading of renewals and betterments an extensive programme has been undertaken. In the Gleichen district two new reinforced concrete drops, and one combination headgate and drop have been constructed on secondary canal "A" to replace unserviceable timber structures. In the Dalroy district three new bridges and two bankgates have been installed, and a new reinforced concrete structure built to replace one of the old wooden drops on secondary canal "B."

The district has been greatly improved during the past year by the grading and repairing of roads and 100 miles of telephone lines constructed by the Provincial Government.

The area under irrigation was 49,752 acres. The principal irrigated crop was wheat, which represented over 50 per cent of the total crop area. Unfortunately, the price per bushel for No. 1 hard wheat was only 80 cents as compared with $1.90 in 1920 and 92 cents in 1921.

The past spring was a backward one, and seeding was not general until the first week in May. General demand for water started during the first week in June. There was a frost free period in this district of 138 days, which is a little above the average. One of the most important features in connection with the season was the entire absence of the serious drying winds which have so often blasted very promising crops in southern Alberta. Undoubtedly the general good yields during the past season, especially on the non-irrigated lands, can be directly attributed to this cause, and to the copious April rains which

created an excellent seed bed. The rainfall by months taken at Strathmore is as follows:—

April, 2·71 inches; May, 0·36 inch; June, 1·30 inches; July, 0·83 inch; August, 2·73 inches.

Useful work has again been done on the small laterals and distributary ditches by the D.N.R. excavators, 273 miles having been cleared of silt and weed growth, the channels being greatly improved and capacities thereby increased.

Eastern Section—

During the past year large sums of money have been expended in this section on repairs, betterments and renewals. Of the timber structures 240 have been repaired and 700 renewed. Sixty-four new small structures have been installed in the system and 16 large concrete structures rebuilt or re-conditioned.

An important improvement has been made on the East Branch main canal by the construction of an automatic reinforced concrete syphon spillway at the inlet of the Antelope creek syphon. This spillway, which is entirely automatic in its operation, will take care of any excess water in the canal at this point, thus greatly facilitating the operation of this section. Some trouble was experienced during the season on the Spring Hill canal by the undermining and partial destruction of the floor, and one wing of the combined headgate and drop at the head of this canal. Temporary works, however, were rapidly constructed and were utilized for the balance of the season.

Three hundred and forty-seven miles of distributary ditches from 2·5 to 10 feet in bed-width have been cleared of silt and weed growth during the past summer by means of the D.N.R. and drag-line excavators.

The area actually under irrigation was 93,375 acres as compared with 88,299 in 1921, being an increase of 5,076 acres. No drying westerly winds were experienced during the past spring and the early moisture was retained in the soil. The summer was very dry, the total precipitation from April 1 to September 30 being only 6·02 inches. The precipitation during April and the first two weeks in May was sufficient for good seeding conditions, but irrigation became necessary early in June, the demand continuing until the end of July. The season was so dry, that crops on the non-irrigated lands were almost a complete failure. The average crop yields on the irrigated lands were very much better than they had been for several years, but the low prices obtained for all farm produce have created a very unsettled condition in the agricultural industry generally. Practically no damage from hail was experienced during the season, and it is considered the district has had the most successful year since 1916. The value of the crops from the irrigated lands has been estimated at over $1,400,000 as compared with last year's estimate of $1,097,000. The average price obtained for wheat was 82 cents per bushel, alfalfa $11 per ton and alfalfa seed $24 per bushel.

A very energetic campaign was undertaken by the Provincial Government with the co-operation of the company to exterminate the grasshopper pest. Many tons of poison were distributed by the farmers along the road allowances and fences, and by the Canadian Pacific Railway Company's officials along canal banks, with very satisfactory results.

Many settlers have greatly improved their holdings during the past year and some very substantial dwellings and farm buildings have been erected.

Lethbridge Section—

The gross irrigable area covered by water agreement in this project is 113,758 acres. Practically all the land has been sold, and approximately 80 per cent of the area lying below the canals is under cultivation. The total area irrigated during the season was 75,558 acres as compared with 56,450 in 1921, being an increase of 19,108 acres. The average value of the crops raised on the irrigated lands in this district was $23.07 per acre, an

increase over the 1921 average yields of $1.32 per acre. The total value of the various crops grown on the irrigated lands during the season has been estimated at $1,339,000 and at $230,000 on the non-irrigated lands. There were 865 actual users of water during the season. The principal crop grown was wheat, of which there were some 23,000 acres harvested with an average yield of 24·5 bushels per acre. Alfalfa was the next largest crop acreage with 12,000 acres, and an average yield of 1·88 tons per acre. Timothy came next with 6,000 acres yielding an average of 1·23 tons per acre. There were 4,660 acres under oats with an average of 43·5 bushels per acre. Two hundred and thirty-two acres were seeded to sunflowers for silage purposes, this crop yielded an average of 11 tons per acre and has been valued at $5 per ton. Potatoes gave an average yield of 153 bushels, and 1,650 acres were planted.

Weather conditions in the early spring were very favourable, the precipitation during the latter part of March and during April was above the average. Although these favourable conditions were followed by a period of dry weather with occasional light showers, the almost entire absence of the drying southwest winds undoubtedly saved this district from a partial crop failure. This absence of wind and the few light showers in June carried the crop along until July when 2·3 inches of rainfall were received. From a line ten miles south of Lethbridge to the International boundary copious rains were received resulting in excellent crops being harvested. The rainfall in inches at Lethbridge during the growing season was as follows: April, 2·57; May, 0·89; June, 1·87; July, 2·30; August, 0·40; September, 0·81; totalling 8·84 inches; the total for the year was 12·34 inches. No damage was suffered from hail, but the grasshopper was again troublesome and did considerable damage in the district in spite of a vigorous poison spreading campaign. There was a frost free period of 142 days extending from May 9 to October 11. Very little new construction was carried out during the year—four new bridges were built on the main canal and on the distributary ditches a number of new timber checks and delivery gates were installed. One specially designed D.N.R. type excavator, one drag-line excavator and one dredge were at work during the season enlarging ditches, removing silt and weeds, raising banks and generally improving the canal system. About twenty-one miles of canal system were gone over in this manner during the past season, the material excavated amounting to approximately 63,000 cubic yards.

TABLE OF YIELDS PER ACRE OF PRINCIPAL CROPS GROWN IN THE CANADIAN PACIFIC RAILWAY LETHBRIDGE SECTION, 1915–1922

Crop	1915	1916	1917	1918	1919	1920	1921	1922	Average for Eight Years
Alfalfa (tons)	3·97	2·80	3·5	2·4	2·7	2·34	2·03	1·88	2·7
Timothy (tons)	1·82	1·85	1·7	1·5	1·0	1·14	1·05	1·23	1·4
Spring wheat (bush.)	40·40	37·40	24·2	15·0	14·5	20·00	11·30	24·60	23·3
Oats (bush.)	75·80	70·80	68·7	28·6	29·4	34·40	22·10	42·30	46·5
Barley (bush.)	47·70	41·60	30·3	18·4	15·2	23·10	15·50	32·70	28·2
Potatoes (bush.)	288·60	255·50	245·0	123·0	129·0	144·10	126·80	151·40	183·0

VALUE OF IRRIGATED CROPS 1922 SEASON

Crop	Acres	Average Yield per Acre	Total Yield	Unit Value	Total Value	Value per Acre
Alfalfa	12,030·20	1·88T	22,647·0	$13 00	$294,411 00	$24 44
New alfalfa	1,591·50	0·22T	345·0	13 00	4,485 00	2 86
Timothy	5,912·80	1·23T	7,285·0	20 00	145,700 00	24 60
Green feed	2,905·50	1·63T	4,751·0	12 00	57,012 00	19 56
Other hay	3,762·00	1·14T	4,285·5	16 00	68,568 00	18 24
Spring wheat	23,230·09	24·46B	568,166·0	0 85	482,941 10	20 79
Oats	4,666·00	43·49B	203,917·0	0 35	71,370 95	15 22
Barley	751·00	32·80B	24,631·0	0 50	12,315 50	16 40
Fall rye	552·00	24·03B	13,267·0	0 55	7,296 85	13 22
Flax	120·00	14·17B	1,700·0	1 70	2,890 00	24 09
Sunflowers	231·75	11·02T	2,555·0	5 00	12,775 00	55 10
Corn	118·75	9·19T	1,092·0	6 00	6,552 00	55 14
Peas-seed	12·00	21·00B	252·0	2 50	630 00	52 50
Potatoes	1,650·57	153·50B	253,351·5	0 36	91,206 54	55 26
Other roots	104·87	6·77T	710·0	7 00	4,970 00	47 39
Garden truck	408·63	4·65T	1,899·0	40 00	75,960 00	186 00
Total	58,050·66				1,339,083 94	Av. 23 07

T. Tons. B. Bushels.

TABER IRRIGATION DISTRICT

This district has had a very successful year, not only from the point of view of crop returns, but also in connection with the operation and management of the system. There are 17,244 irrigable acres in the district, and of this area some 13,122, representing 76 per cent, were actually irrigated. The operation of the system has been very satisfactorily carried out by the manager with the assistance of two ditch riders.

Active operation of the system was not commenced until June 6, owing to the fact that the heavy snow experienced during the month of April was mostly absorbed by the soil, and the land was therefore in excellent condition at the time of seeding. Furthermore, with the light rains in May and the absence of the usual westerly winds, the available moisture was well conserved. Demand for water became general by June 20, and the system was running at full capacity by June 22, and so maintained until July 10.

Seeding operations being at least two weeks later than usual, the summer irrigation of grain crops continued until August 10. The system was operated for some weeks after the recognized irrigation season, in order to afford an opportunity for fall irrigation. Many farmers took advantage of this, and 5,360 acres were fall irrigated. During the period June 1, to November 8, 23,894 acre-feet of water were diverted at the headworks of the system, this is 11,100 acre-feet less than were diverted in 1921, and is accounted for by the fact that there was considerably less demand for fall irrigation during 1922. With no fall rains and very little moisture remaining in the soil, it can reasonably be anticipated there will be a record early demand for water in 1923.

From the crop report of this district it is interesting to note, that the wheat yield averaged 21·5 bushels per acre and oats 45 bushels. A number of farms had wheat averages of from 30 to 35 bushels per acre, and one averaged 40 bushels. Some farms had oat yields averaging from 60 to 85 bushels per acre.

In the secretary-manager's annual report to the trustees on the year's operations, it is pointed out, that as many of the farms in this project have been cultivated from ten to fifteen years a good portion of the plant food has undoubtedly been exhausted, and if big crop returns are to be expected in the future special attention must be given to soil building. The report further suggests a variety of crops which would re-establish soil fertility, and certain farming methods which should also be followed.

The average farm unit under this project is 190 acres, an area too large for intensified farm development under irrigation methods. The farmers realize this, and efforts have already been made to dispose of portions of their holdings, but up to the present without much success. The erection of suitable dwellings and farm buildings on these surplus irrigated lands would greatly facilitate their disposal.

CANADA LAND & IRRIGATION COMPANY'S PROJECT

This has been a very successful year for the farmers under this project, splendid crops having been harvested. Weather conditions were particularly favourable and the frost free period covered 136 days—from May 23, to October 6, giving the farmers an exceptional opportunity for growing potatoes and garden produce. The fact that during the past few years sweet corn, cucumbers, squashes, cantaloupes, water melons, and tomatoes have been grown in considerable quantities, and matured successfully on this project, is sufficient evidence of the favourable climatic conditions during the growing season. The area actually irrigated was 9,809 acres of which 5,267 were seeded to wheat and yielded 27·9 bushels per acre. At an average price of 74 cents per bushel this crop realized $108,241.87. The second largest acreage was alfalfa hay with 846·4 acres, yielding 2,835 tons or an average of 3·3 tons per acre. With the

market price at $15 per ton this crop therefore realized a per acre return of $49.50. From some 380 acres of potatoes an average yield of 190·7 bushels per acre was obtained, at 40 cents per bushel, this crop produced a per acre return of $76.28. The total estimated value of the crops grown on the 8,751·7 acres from which crops were harvested was $242,940.27 which represents an average yield value per acre of $27.73.

As an indication of what can be produced on a section (640 acres) of irrigated land, and the number of head of stock that can be carried, the following figures for one farm are considered noteworthy: A dairy herd of 23 cows, 41 head of pure-bred Aberdeen Angus cattle, 56 head of pure-bred Berkshire brood sows, 25 head of pure-bred Suffolk sheep fattening for the market, 1 carload of commercial hogs, 4,750 wether lambs, 250 head of old ewes, and in addition the wintering of 175 head of yearling steers. The whole of this live stock is being wintered and furnished with feed which was produced on 640 acres of irrigated land, with the exception of some feed barley which was purchased. Had the 100 acres which was seeded to wheat been put into barley, no outside purchase whatever would have been necessary. The feed produced consists mainly of alfalfa hay, sunflower ensilage, roots, barley, oats, and peas.

As most of the settlers on the irrigated lands have only been resident for two years, their whole time has necessarily been devoted to farming their land, and getting themselves established generally. Various community organizations are already contemplated, and will undoubtedly become established within a year or two. Houses and farm buildings to the value of $157,740 have been constructed during the past year.

The company built twenty-two new wooden structures on the lateral systems and re-conditioned twelve of the existing small lateral structures. Some trouble and a good deal of expense have been caused by the drifting into the canals of tumbling weed and Russian thistle from the non-irrigable lands to the west. The removal of these weeds necessitated going over 50 miles of main canal and 55 miles of laterals. Forty miles of the main canal required going over twice and 50 per cent of the laterals three times. Before the water was turned into the system the weeds were destroyed by burning, but afterwards they had to be removed by means of teams and Jackson hay forks, a much more expensive operation.

The company constructed 10 miles of drainage ditches in the western district for the disposal of surplus surface irrigation water. Along the Little Bow section of the main canal 69,000 cubic yards of material were moved in connection with the improvement of the canal in this vicinity, chiefly in reducing the overburden at critical points where sliding had occurred.

Lethbridge Northern Irrigation District

As noted in the preceding annual report, the construction work on this project was well under way during 1921.

Work was continued during the past year. The Provincial Irrigation Council continued to exercise general supervision of the work. No change in the board of trustees was made during the year, Mr. Croft, the chairman, being re-elected at the expiration of his term in December. Mr. Muckleston continued as chief engineer during the year, and no change was made in the staff except the addition of necessary assistants on structures.

Structures.—Early in the season the Irrigation Council awarded further contracts for concrete and wooden structures. The contract for concrete

structures on Monarch Branch, and all canals and laterals east of Keho lake was awarded to Mr. H. G. MacDonald at prices as below.

MATERIAL SUPPLIED

Cement—9,200 bbls at $3.90	$ 35,880 00
Reinforcement—150,000 lbs. at $0.079	11,850 00
Timber in structures—16,500 F.B.M. at $54.00	891 00

LABOUR AND PLANT

Transportation—131,000 ton-miles at $0.48	62,880 00
Machinery erected—45,000 lbs at $0.03	1,350 00
Timber in place—16,500 F.B.M. at $30.00	495 00
Excavation, class I—3,000 cu. yds. at $1.50	4,500 00
Excavation, class II—14,000 cu. yds. at $0.42	5,880 00
Trenching—4,000 cu. yds. at $0.78	3,120 00
Back-fill—12,000 cu. yds. at $0.48	5,760 00
Formed surface—225,000 sq. ft. at $0.132	29,700 00
Concrete—6,850 cu. yds. at $4.56	31,236 00
Reinforcement—150,000 lbs. at $0.02	3,000 00
Waterproofing—60,000 sq. ft. at $0.072	4,320 00
Filter gravel—1,000 cu. yds. at $2.75	2,750 00
Riprap—1,650 cu. yds. at $2.80	4,620 00
Embankment—5,000 cu. yds. at $0.36	1,800 00
Extra work man-hours—10,000 at $0.48	4,800 00
Extra work team-hours—4,000 at $0.90	3,600 00
Total	$ 218,432 00

Mr. H. H. Boomer secured the contract for all timber structures at prices as follows:—

Timber in place—3,416,290 F.B.M. at $14.00	$ 47,828 06
Pile driving—10,840 lin. ft. at $0.75	8,130 00
Excavation, class I—3,200 cu. yds. at $0.40	1,280 00
Excavation, class II—33,480 cu. yds. at $0.30	10,044 00
Back-fill—	
Refilling—18,560 cu. yds. at $0.30	5,568 00
Rehandling—52,620 cu. yds. at $0.30	15,786 00
Trenching—14,450 cu. yds. at $0.50	7,225 00
Haul—40,130 ton miles at $0.40	16,052 00
Machinery erected—42,240 lbs. at $0.03	1,267 20
Extra workman—	
Hours—3,950 at $0.40	1,580 00
Team-hours—6,760 at $0.80	5,408 00
	$ 120,168 26

Messrs. Smith Bros. & Wilson were awarded contract for concrete in principal railway crossings as below:—

Excavation, class II—3,000 cu. yds .at $1.25	$ 3,750 00
Concrete in place mass—872 cu. yds. at $15.70	13,690 40
Back-fill—1,500 cu. yds. at $0.55	825 00
Riprap—150 cu. yds. at $3.75	562 50
Embankment—200 cu. yds. at $0.50	100 00
	$ 18,927 90

Work was carried on during the season under these contracts as well as those awarded the previous year to Messrs. A. G. Creelman & Co. Scarcity of labour during harvest delayed construction to some extent, but fair progress was made throughout. On December 31, structures were completed with the following exceptions:

Headworks.—Approximately 75 per cent is completed with every evidence that construction will be sufficiently advanced to permit of diverting water by April 15, 1923.

Oldman Flume.—Concrete, steel work, and 55 per cent of the sheet metal flume is completed. No difficulty should be experienced in completing before required.

Willow Creek Flume.—Concrete and steel-work is completed, and sheet metal flume will be erected after completion of Oldman flume.

Rocky Coulee and Kennex Syphons.—Wood-stave pipes are in place at both sites, and remaining work consists principally of tightening bands.

A cloudburst in July in this locality caused some damage at Kennex, a number of footings being overturned, and a considerable number towards centre of syphon being submerged by filling of slough. Dykes were later placed across slough, and footing area unwatered to permit of construction of pipe.

Keho Lake Outlet.—Excavation only has been completed at this point, but work was under way during the winter, and structure should be completed before spring.

General.—The Colonization Branch of the Irrigation Council, of the province of Alberta, has conducted a campaign during the greater part of the season for the sale of surplus land within the district. This was advisable because of the large average size of the holdings and will eventually result not only in a larger population to share the expenses of the district, but in more intensive farming on the smaller individual farms.

All contracts call for completion before May 1, 1923, and little doubt remains that they will be at least far enough advanced to permit of operation by that date.

UNITED IRRIGATION DISTRICT

Construction on this project was continued during the year under the engineering supervision of Mr. D. W. Hays with Mr. J. Petersen as secretary of the district in charge of finances. The Provincial Irrigation Council exercised general supervision over both construction and finances.

Extension of Boundary.—During the year the district boundary was extended northward to include sections 11, 12, and 13, township 6, range 26, west of the 4th meridian, and sections 7, 8, 9, 16, 17, and 18, in township 6, range 25, west of the 4th meridian. This increases the irrigable area by some 2,820 acres and the total area irrigable in the district is now estimated at 26,370 acres.

Excavation.—Work on canal system was resumed with favourable weather in the spring, and carried on until completion in November. During the early part of the season contracts were only awarded to ratepayers as in the previous year, but it became apparent during harvest that excavation would not be completed in time if outside help was not secured. A number of contracts were therefore awarded to non-ratepayers.

All earthwork was completed by the end of the season and the final estimate showed the following quantities to have been moved:—

Earth	799,521 cu. yds., cost per cu. yd., $0.201	$ 160,709 83
Loose rock	8,196 " " 0.494	4,047 93
Solid rock	307 " " 0·909	279 17
	——— Misc. fencing, Force account, etc.	3,776 08
Total	808,024 cu. yds., cost per cu. yd $0.2089	$ 168,813 01

The total length of main canal and lateral ditches excavated was 172·86 miles with capacities varying from 5 to 200 cubic feet per second.

Concrete Structures.—These structures were built by the district on force account. When work was abandoned for the season in November owing to cold weather, all had been completed with the exception of the main canal chute into Cochrane lake which was 50 per cent complete, and a small number of combined drops and headgates on Glen lateral. Work will be resumed on these structures as early as possible in the spring and no delay in operating the system during the coming season is anticipated.

The structures completed consist of the diversion dam, main canal chute at Hillspring, Cochrane lake outlet and a small number of drops, culverts and turnouts. Of these the dam is the only considerable structure, it being of

gravity section, 7·5 feet high and 300 feet long between abutments, and having a computed discharge capacity of 25,000 second-feet with water-surface two feet below the top of the abutments.

Timber Structures.—During the winter of 1922 a contract for supplying lumber was awarded to the McFarland Lumber Company of Calgary at the following prices, f.o.b. Cardston:—

287,421 F.B.M. Douglas fir, No. 1 common	$ 10,335
716,595 F.B.M. Mountain fir, No. 1 common	18,592
Totals 1,004,016	$ 28,927

This was an average price of slightly under $29 per thousand. Hauling of this and other material was carried on all winter by the ratepayers of the district.

Most of the timber structures were built by contract, only some nineteen bridges and two flumes being constructed under force account. Contracts were awarded by the Irrigation Council on July 21 as below:—

LARSON & CAULDER

Item	Number	Quantity	Unit Price	Amount
Culverts	86	100,000 F.B.M.	$ 12 00	$ 1,200 00
Checks and drops	308	203,000 "	15 00	3,045 00
Turnouts	118	47,000 "	14 00	658 00
Common excavation		2,000 cu. yds.	0 40	800 00
Trench excavation		3,000 "	0 60	1,800 00
Back-filling		1,000 "	0 35	350 00
				$ 7,853 00

HENKER & MITCHELL

Item	Number	Quantity	Unit Price	Amount
Culverts	120	200,000 F.B.M.	$ 17 50	$ 3,500 00
Checks and drops	400	280,000 "	18 00	5,040 00
Turnouts	200	80,000 "	20 00	1,600 00
Common excavation		3,000 cu. yds.	0 40	1,200 00
Trench excavation		5,000 "	0 50	2,500 00
Back-filling		2,000 "	0 40	800 00
				$ 14,640 00

Messrs. Henker & Mitchell abandoned their contract after doing a small amount of construction, and the work was later awarded to Messrs Oland & Scott at the following prices:—

—	—	Unit Price	Amount
Culverts	All quantities the same as Henker & Mitchell contract.	$ 14 50	$ 2,900 00
Checks and drops		18 50	5,180 00
Turnouts		18 50	1,480 00
Common excavation		0 32	960 00
Trench		0 98	4,900 00
Back-filling		0 32	640 00
			$ 16,060 00

The inclusion of the additional lands in the district increased the quantities to a considerable extent. Progress on both timber construction contracts on December 31, 1922, is given in table below:—

Structure	Total Number	Built Dec. 31, 1922	To be Built in 1923
Bridges	21	19	2
Culverts	193	142	51
Checks and drops	801	629	172
Turnouts	475	341	134
Private bridges	2	0	2
" culverts	94	27	67
Flumes	4	2	2
Flume ditch crossings	10	0	10
	1,600	1,160	440

All excavation for foundations was completed before freeze-up, construction is being carried on during the winter, and it is expected that these contracts will be completed before the 1923 irrigation season commences. Only back-filling under foundations is included in the timber contracts, other back-filling being done by force account when priming canals. During the season of 1922 water was run down the main canal as far as Hillspring chute and through a number of laterals so that this back-filling is approximately 10 per cent complete.

General.—No further bond issue was made during the past year but an early issue of a further $100,000 is contemplated. This amount is thought to be sufficient to complete the project. As previously noted it is expected that the entire project will be under irrigation during the 1923 season.

SOUTH MACLEOD IRRIGATION DISTRICT

The early history of the district was outlined in last year's report up to the point where the Provincial Legislature on March 28, 1922, passed an enabling Act under chapter 28 of the 1922 Statutes. This gave the Lieutenant-Governor in Council power to guarantee the principal and interest on a debenture issue up to $2,050,000. Under this Act provision was also made whereby the Irrigation Council of Alberta was given exclusive power to enter into contracts for the construction of the works.

The necessary by-law under the provisions of the Irrigation Districts Act was voted upon by the members of the district on May 15, 1922, and passed almost unanimously.

No further action has been taken by the Provincial Government of Alberta towards financing this project and it is understood that none will be taken until the settlement of the Lethbridge Northern Irrigation district, whose bonds were sold under Provincial Government guarantee, is further advanced.

The Board of Trustees of this district as at present constituted is as follows: Mr. R. B. McNichol of Macleod, Chairman; Mr. A. B. McFadden of Macleod, Secretary; and Mr. W. J. Murphy of Ewelme, Trustee.

ROBSART-VIDORA IRRIGATION DISTRICT

This project, situated south of the town of Maple Creek, comprises an area of roughly 29,000 acres and the water supply will be taken from the Frenchman river valley.

In view of the information contained in the detailed report, estimates, and plans furnished to the district officials during the past year, the parties interested have decided to proceed with, and have petitioned for, the formation of a district under the provisions of the Saskatchewan Districts Act, 1920. The petition proved satisfactory to the Department of Highways of the Government of the province of Saskatchewan, and the Provincial Attorney General's department has been instructed to draft the notice required to be advertised in accordance with the afore-mentioned Act. The irrigable area is approximately 10,000 acres which it is estimated can be irrigated at a construction cost of about $34 per acre.

LITTLE BOW IRRIGATION DISTRICT

This project consists of a number of individual pumping schemes situated in the valley of the Bow river and comprises an area of roughly 9,640 acres. Last year's report contains an outline of the history of this district from its inception to the point where plans had been prepared by the engineer appointed by the district and the necessary advertising under the provisions of the Irrigation Act was about to be undertaken. The approval of plans and the necessary

reservation of water from the Highwood river was obtained from the Minister of the Interior on April 10, 1922. Early in the year a few of the original petitioners decided to withdraw from the district, as they considered their schemes too small to be an economic success. The district duly published its notice in the *High River Times* in April, 1922, and authorization to construct works was issued on July 15, 1922.

Under certain provisions of the Irrigation Districts Act of Alberta only the actual owners of lands are entitled to sign a petition for the erection of an irrigation district, and further it is necessary that the owners of at least 50 per cent of the proposed district must sign the petition. In this particular case, however, it was ruled by the Irrigation Council of Alberta that owing to the peculiar nature of the project, and to the fact that the works consisted of individual installations, the signatures of all the owners affected would be required. Under this ruling some of those signing the original petition were declared ineligible for inclusion within the district, owing to the fact that they were not the registered owners of the lands affected. Arrangements are being made whereby sufficient water will be carried through the system for the accommodation of these prospective owners, and for their inclusion in the district when they have acquired title.

In July a petition was filed with the Minister of the Interior in accordance with section 161 of the Alberta Irrigation Districts Act, by two of the original petitioners, requesting permission to have their lands excluded from the Little Bow Irrigation district. The necessary permission was duly given, and two schemes with a total irrigable area of 209·5 acres were excluded. The Ministerial order was made and promulgated in the *Alberta Gazette* on August 4, 1922. The same order further changed the content of the district by the inclusion of two new schemes with a total irrigable area of 216·1 acres.

The irrigable area at present actually included in the district is 2,625 acres, and the estimated cost of constructing the community works is $36,100 which works out to $13.75 per irrigable acre. As, however, the Government of the province of Alberta has decided to purchase bonds up to $18,000 in consideration of the use of the works in connection with its license for the diversion of 50 cubic feet per second for the domestic use of the settlers along the Little Bow river, the cost per acre to the individual is reduced to $6.90. The area which has been temporarily excluded amounts to 269·80 acres, and when these lands become eligible for inclusion in the district the per acre cost and yearly assessment will be reduced proportionately.

The trustees of the district on October 25, 1922, called for tenders for the construction of the headworks on the Highwood river, and for the other necessary works to convey the water to the Little Bow river. The tenders were opened by the Irrigation Council on November 8, 1922, the successful tenderers being Messrs. A. G. Creelman & Co. of Calgary for the headworks and river protection for $5,566.00, Mr. Martin Fogarty of Travis for the canal excavation for $14,510.60, and Mr. H. H. Boomer of Barons for the timber structures and fencing for $5,353.78. The total of the successful tenders amounted to $25,430.37.

Construction was started on the headworks and river protection work in December 1922, and has progressed as rapidly as the varying weather conditions permitted. It is expected the headworks will be completed at an early date in the spring. The excavation for the main canal will, weather permitting, be commenced in March and the contractors time limit expires on June 15, 1923. The estimates show about 58,000 cubic yards of material to be excavated from this canal. The engineering work is being undertaken by Messrs. Haddin & Miles of Calgary, who also undertook the surveys for the various individual schemes.

NEW WEST IRRIGATION DISTRICT

The surveys and estimates of cost for this district were completed during the 1921-22 season, and received the minister's approval on January 31, 1922. As originally organized the district comprised 7,629·8 irrigable acres, the lands lying almost wholly in the west half of township 14, range 16, west of the 4th meridian. The water for these lands will be diverted from the Bow river through the works of the Canada Land & Irrigation Company.

The boundaries of this district proposed by our field engineers as the result of surveys and field studies were not entirely acceptable to the organizers of the district, therefore certain lands were excluded and other lands substituted. This adjustment reduced the irrigable area from 7,629·8 acres to 4,501·2 and increased the per acre construction cost from $4.37 to $4.54.

Notice of the application to form the district under the provisions of the Irrigation Districts Act of Alberta was published in the *Alberta Gazette* March 15, 1922.

The district was formed by a unanimous vote of the ratepayers and the election for trustees was held on July 14, 1922, when Messrs. C. W. Gray, C. Watterberg, and P. Love were duly declared elected. The Ministerial order for the formation of the district, giving its name, content, date and place of election, and the names of the trustees was promulgated on July 24, and appeared in the *Alberta Gazette* July 31, 1922.

The question of carriage rights for the water for this district, through the canal system of the Canada Land & Irrigation Company, was the cause of some delay in advancing this project. It has been tentatively agreed between the parties concerned, that payment for the right to divert, carry, and store the necessary water, be made in a lump sum from the sale of debentures, at the rate of $31 per acre of the irrigable land in the district, and for the operation and maintenance of the works of the company, a charge of $1.25 per irrigable acre per annum be made. The agreement has been drawn, and now only awaits the concurrence of the directors of the Canada Land & Irrigation Company, Limited, and the Board of Trustees of the district.

An Act to assist this district by guaranteeing their debenture issue up to the estimated amount required, i.e. $209,500, was assented to on March 9, 1923.

Advertising in accordance with the provisions of the Irrigation Act is now being done, and upon completion of the four weekly insertions, authorization for construction of the necessary works will be issued. The necessary by-law, authorizing the trustees to proceed to raise a loan of $209,500 upon the credit of the district and with the guarantee of the province, was voted upon affirmatively. This amount will be sufficient to cover the preliminary expenses, construction cost of the works within the district, the purchase of carriage rights from the Canada Land & Irrigation Company, and will also take care of interest charges upon the debentures for a sufficient time to allow of the completion of the works.

Sevenpersons Drainage Basin Investigations

MEDICINE HAT EASTERN IRRIGATION DISTRICT

The proposed flood irrigation scheme for this district, diverting water from Ross and Bullshead creeks, was fully reported upon in last year's report. The scheme as recommended by the Calgary office was approved as feasible by the Minister on March 17, 1922. The Board of Trustees of the district was furnished with a copy of the report, and they requested that a revision be made in the irrigable area under the Bullshead creek scheme. They desired that certain irrigable lands be withdrawn, and that the canal system be extended to include other lands. The feasibility of this proposal was determined late in April, and

the result of the investigation showed, that with a slight increase in cost of construction the desired amendment could be made to the district. As the owners of the lands were signatories to the original petition, proof of their willingness to withdraw from the district was necessary and was finally obtained.

The district then submitted their scheme to the Government of the province of Alberta for approval, requesting that the credit of the province be pledged as security for their bonds. After an investigation of this project by the Irrigation Council of Alberta, a report was submitted to the Minister of Railways and Telephones on August 29, 1922, recommending that the necessary financial backing be not given. The concluding portion of the report stated:—

> The Bullshead scheme cannot be recommended. The Ross creek scheme, while possessing some uncertainties, has considerable merit in view of the low estimated cost per acre and the climatic conditions. There is, however, not sufficient certainty about the success of the proposed method of irrigation to justify the recommendation that the credit of the province be pledged for the security of the bonds.
>
> The Irrigation Districts Act provides splendid machinery for the collection of irrigation rates, and for the forfeiture of the lands if rates are not paid. Irrigation rates take precedence over all other taxes. The Government has thus gone a long way towards providing ample security and assisting financing, and as the whole cost of this part of the project would be only about $20,000, it would seem that the district should be able to interest capital if they could show sufficient merit in the scheme itself.

Following this decision it was considered that before recommending cancellation of the water reservation of these sources of supply, reasonable time should be given in which to enable the district to obtain outside financial assistance. Advice was received from the district officials on February 2, last, to the effect that they would go into the problem of financing the district immediately, but no definite action has been taken up to the present.

MEDICINE HAT SOUTHERN IRRIGATION DISTRICT

The first survey for a project to serve 5,300 acres from Sevenpersons and Paradise creeks at an estimated per acre cost of $49.80 was fully reported in the 1920-21 report. A district was duly erected, and officers appointed under the provisions of the Irrigation Districts Act of Alberta in January, 1921. The project was reported upon by Mr. G. G. Anderson, a consulting engineer of Denver, Colorado, on behalf of the Provincial Government in April, 1921, and not approved as water supply was not considered satisfactory. In consequence the Government of the province of Alberta declined to pledge the credit of the province in support of the necessary bond issue. As the district officials were not satisfied with this report, they employed Mr. D. W. Hays, a consulting engineer, of Calgary, to investigate the project and if possible outline for them an alternative scheme that would offer better security. In July, 1921, Mr. Hays submitted a report to the district suggesting that the irrigable area be reduced to 3,000 acres, and that each unit contain at least 80 irrigable acres. In view of Mr. Hays' report and suggestions, the district requested that some further field-work be undertaken by this department on their behalf and a further report and estimate submitted. The necessary further surveys were therefore undertaken during the winter of 1921-22 and a report and estimate submitted for the irrigation of 3,000 acres from the same sources of supply. Extracts of the essential features of this report were published in the 1921-22 report. Attention was drawn to the fact that out of sixteen owners affected by the revised district, only two were residents, and of the thirty-nine quarter-sections affected, twelve were owned by one individual. Owing to this condition and to the fact that a study of the water supply indicated sufficient water to furnish a depth of from 15 to 18 inches during only seven out of nine years, some further investigation was considered necessary. Records on Paradise creek were only available for a few months of the year 1920, and for 1921, entirely insufficient to justify a definite allocation of water and a considerable

expenditure in money. The project was therefore recommended to be held in abeyance until further records of the available discharge of Paradise creek could be obtained.

During the past season further study was made of the reservoir possibilities in the Sevenpersons drainage basin, and in the late fall it was found possible to place a survey party in this vicinity to ascertain the possibilities of a more economical storage reservoir. In his report Mr. Hawkins, the engineer in charge, states in part as follows:—

> The maximum area irrigable, with any degree of certainty of an adequate water supply, is 2,500 to 3,000 acres. The area should be near the reservoir, in a compact form in order to reduce losses to a minimum, and should include the hay flats immediately north of the reservoir. The reservoir need not be of a greater capacity than 13,000 acre-feet. Very little storage would be carried over from year to year, and in a year such as 1919 the reservoir would be of practically no use. The seepage and evaporation losses would be unusually high owing to the relatively large area of the basin and the high temperature prevailing in the district during the summer.
>
> The total cost of constructing a reservoir for serving the area referred to above is $82,138, or at the rate of $6.20 per acre-foot stored.

The possibilities of utilizing this storage for the irrigation of the most suitable adjacent lands are now being investigated. The results of this work together with an estimate of cost will be duly transmitted to the secretary of the district, and if the amended scheme is attractive enough in regard to per acre cost, the necessary action to change the content of the district can be taken.

HIGHWOOD RIVER IRRIGATION PROJECT

The first field investigations of this project were made in the year 1920, when a reconnaissance was made to ascertain the feasibility of diverting the Highwood river to lake McGregor as a water supply for the proposed Retlaw-Lomond district. It was found that under such a diversion canal there would be a large area, mainly in the Highwood River district, which would at some time require water for irrigation from the Highwood river. In 1921, preliminary surveys were made to determine the feasibility of this project and consisted mainly of surveys of proposed reservoir sites, main canals, and main distributaries.

Field Surveys Year 1922.—A standard party of three plane-tables was employed during the season to make a complete plane-table survey of the project. Surveys were commenced in May and completed in December. During the season the party completed the following work:—

155,930 acres of plane-table topography, 184 miles of levels.
7 permanent iron bench-marks established.

Canal Design.—The main and branch irrigation canals have been designed to carry a maximum quantity of water sufficient to supply 50 per cent of the irrigable area with an application of six inches in depth in fifteen days. The storage canals have been designed for the following capacities.

Highwood river to Tongueflag reservoirs—1,200 second-feet.

Tongueflag reservoirs to Frank lake—600 second-feet.

Seepage losses were estimated at 6 second-feet per million square feet of wetted area. The total irrigable area is approximately 52,435 acres, and the gross canal capacity from Frank lake is 568 second-feet.

Water Supply.—The Highwood river is an important tributary of the Bow river and in considering the available water supply the prior appropriations on both streams have had to be considered. A fairly complete study has been made of the Bow River drainage basin, and after making due allowance for all prior appropriations, it is found that with the above storage there is sufficient water available from the Highwood river for the project. Assuming an irrigation

factor of 80 per cent, and a net duty of 18 inches, the water requirements from Frank lake are as follows:—

Net water required on approximately 52,435 acres	62,954 acre-feet
Absorption losses at 22·4 per cent of the gross	18,172 "
Total water required	81,126 "

Considering the period of years from 1918 to 1921 inclusive which are low-water years, and providing for all prior appropriations in the drainage basin, it is estimated that the following quantities are available for the project.

Year	Water Available
1917–18	114,786 acre-feet
1918–19	78,512 "
1919–20	215,222 "
1920–21	136,170 "

The following is an estimate of the average monthly requirements from Frank lake during the irrigation season:—

May	10 per cent	=	8,113 acre-feet
June	30 "	=	24,338 "
July	30 "	=	24,338 "
August	20 "	=	16,224 "
September	10 "	=	8,113 "
	100 "	=	81,126 "

Soil Surveys.—Eighty-six groups of soil samples, carefully chosen to represent the soil conditions over the whole project, were taken. These samples were tested for alkali with the following results:—

45	groups	showed either weak or no alkali.			
11	"	"	moderately strong alkali from		3 to 5 feet
13	"	"	"	"	1·5 to 5 "
17	"	"	"	"	0·5 to 5 "

The lands plane-tabled extended over a rather extensive area with more or less irregular topographic features and varied soil conditions. The predominating soil throughout was found to be light clay loam interspersed with isolated patches of sandy loam on the high ground, and heavy clay loam in the bottom of drainages.

In the Highwood River district the soil, generally speaking, is a light clay loam, which tends to be of a heavier nature in the northern than in the southern portion. Sandy soil is found in patches on the southern and eastern slopes of the high land, isolated by Long coulee, while heavy clay is found on the wide flats forming the head of Long coulee.

This district, as a whole, was found to be particularly free from alkali and although several of the soil samples taken showed strong alkali, it was found in every case that this alkali condition existed only in the bottom of drainages, and that the slopes immediately above were free from it.

In the Brant district, the soil of the area found to be economically irrigable is a light clay loam. The land has a good slope and is free from alkali. Throughout the remainder of the area plane-tabled, which for the most part extended along the flats of West Arrowwood creek, the soil is extremely heavy and contains a great deal of it.

In the drainage basin of Frank lake the soil varies from a sandy loam in the higher portions of the slopes to a heavy clay loam in the bottom lands around the lake. The lands to the north and east of the lake show a high alkali content, and will require further study before being classified for irrigation purposes; those lying to the west of the lake appear to be free from alkali conditions.

Description of Project.—The general idea of the proposed project is to irrigate an area of land lying north of the Little Bow river in townships 14, 15 and 16, in ranges 22 to 26 inclusive, which contains approximately 51,460 irrigable acres, together with a small area lying south of the town of Brant in township 17, range 26, west of the 4th meridian, which contains some 880 irrigable acres.

A third area, containing about 25,000 irrigable acres lying east of the town of High River in the drainage basin of Frank lake, is commanded by the main canal of the proposed project, but owing to lack of storage facilities above this area it has not been included in the project.

The proposed plan of irrigation consists of diverting water at a point on the left bank of the Highwood river about six miles southwest of the town of High River, and bringing it in a canal of 1,200 cubic feet per second capacity a distance of two miles to a reservoir which utilizes a draw, tributary to Tongueflag creek, and also a portion of the main valley of the latter stream, for storage purposes. This reservoir, consisting of an upper and lower basin, acts as a regulating basin, and enables the use of a smaller canal out of the reservoir than the one brought to it. From the Tongueflag reservoirs the water is re-diverted and brought by a canal of 600 cubic feet per second capacity a distance of ten miles to a second point of storage termed Frank Lake reservoir, which utilizes a lake lying six miles east of the town of High River. The water is re-diverted from Frank Lake reservoir and brought by a canal of 570 cubic feet per second capacity, a distance of about twenty-two miles along the left bank of the Little Bow river to the northwest corner of the large irrigable area around the town of Champion, and then distributed throughout the area by means of the main canal continued and lateral canals. The small area lying south of the town of Brant is served by two lateral canals which take off the main canal about ten miles below Frank Lake reservoir.

Intake.—The intake of the proposed project is located in the NW. ¼ section 30, township 18, range 29, west of the 4th meridian, where the diversion is made at the elevation of the water surface in the river without the use of a weir. By this means the only structures required at the intake consist of reinforced concrete headgates with a capacity of 1,200 cubic feet per second together with two jetties on the right bank of the river above the intake, to ensure the present channel of the river being maintained.

Main Canal.—The section of main canal from the headgates to the Tongueflag reservoirs consists of a grade canal to a point above the reservoir, and the delivery to the reservoir is made by means of a chute 200 feet in length with a vertical drop of 15 feet.

The section of main canal from the lower Tongueflag reservoir to Frank Lake reservoir is an expensive length of canal which includes several structures. These structures consist of:—

(1) Five 5-foot drops in that portion of the canal from the reservoir to the flat followed by the Highwood river.
(2) A steel railway bridge across the canal.
(3) A steel girder flume crossing of the Highwood.
(4) A cut 6,300 feet in length with a maximum depth of 16 feet.
(5) Eight 5-foot drops and two chutes in that portion of the canal between the deep cut and Frank Lake reservoir. The vertical drop effected by these latter structures amounts to 92 feet.

The portion of the main canal along the Little Bow river is also somewhat expensive owing to sections where the slopes of the river bank are steep, reaching in some places to 20 per cent. These steep sections are, for the most part short, and in no place are they considered excessive for canal construction. The structures on this section consist of 7 timber flumes ranging in length from 200 to 450 feet, and with an average maximum height of about 20 feet.

After leaving the bank of the Little Bow river the canal follows along a gentle slope as far as the head of the Long coulee lateral. At this point, the main canal makes a crossing of about 11,400 feet in length to command an area containing about 28,000 irrigable acres, which is isolated from the main slope of the district by Long coulee and another drainage course. The crossing is

effected by means of four 5-foot drops, a flume 1,800 feet in length, and a fill 5,050 feet in length with a maximum height of 16·5 feet. From the lower end of the crossing to the eastern extremity of the district, the main canal presents no further difficulties, and with the exception of several small drops to take care of excessive fall in the general slope of the land, no further structures are required.

Reservoirs.—In order to make the most economical use of the available water supply from the Highwood river the following reservoirs have been included in the project:—

Name	Location	Superficial Area (Acres)	Capacity (Acre-feet)
Upper Tongueflag	Tp. 19, rge. 29, W. 4	568	7,240
Lower Tongueflag	Tp. 19, rge. 29, W. 4	455	8,780
Frank lake	Tps. 18 and 19, rges. 27 and 28, W. 4	7,480	55,369
Total capacity			71,389

The upper Tongueflag reservoir, which utilizes a draw tributary to Tongueflag creek, requires for the proposed storage, a dam at its lower end, which is 920 feet in length with a maximum height of 57 feet, and with outlet gates to the lower Tongueflag reservoir with 1,200 cubic feet per second capacity. This dam is located on a line running from a point in the SW. ¼ of section 15, township 19, range 29, west of the 4th meridian across the northwest corner of section 10 to a point in the NE. ¼ of section 9.

In addition to the dam, this reservoir requires three dykes across saddles of land between the draw and other drainages to the river.

The first of the dykes is located at the upper end of the draw where a fill 2,830 feet in length with a maximum height of 5·6 feet is required. This fill is located in section 3, township 19, range 29, west of the 4th meridian.

A second fill is required in the SE. ¼ of section 10, township 19, range 29, west of the 4th meridian where a fill 550 feet in length with a maximum height of 7 feet is required, while a third fill located in the SW. ¼ of section 15, township 19, range 29, west of the 4th meridian is 120 feet in length and has a maximum height of 5 feet.

The lower Tongueflag reservoir which is immediately below the upper reservoir requires a dam 2,570 feet in length with a maximum height of 48·5 feet, and with outlet gates of 600 cubic feet per second capacity to the canal between this reservoir and Frank Lake reservoir. The location of this dam is along the eastern boundary of section 15, township 19, range 29, west of the 4th meridian.

A spillway to guard against freshets in Tongueflag creek itself at times when the reservoir might be at full capacity level is provided in the canal just below the outlet from the reservoir.

The total area of land flooded by both the upper and lower Tongueflag reservoirs amounts to 1,023 acres, of which about 400 acres is fairly good land, while the balance is located in the bottoms of the drainages and is worthless except for grazing purposes.

Frank Lake reservoir, which provides approximately 80 per cent of the proposed project's storage facilities, is very low in cost as regards structures, as a fill 1,250 feet in length with a maximum height of 13·6 feet together with outlet gates with a capacity of 570 cubic feet per second constitute the structures required for this reservoir.

The proposed reservoir when full raises the level of the present Frank lake about 10·5 feet and floods about 4,200 acres of land. This land is for the most part only suitable for grazing purposes, and is not considered valuable from an

agricultural standpoint, as it was found that in many parts of the area flooded, the alkali content was extremely high.

Alternative Intake.—The total cost of the project, exclusive of "engineering and contingencies" has been estimated at $1,800,830, of which amount approximately $420,000 is required to cover the cost of the canal and reservoirs up to the point of the flume crossing of the Highwood river in the SW. ¼ section 17, township 18, range 28, west of the 4th meridian, and in so far as the irrigation project is concerned, the benefits derived by making diversion at the present intake are confined to the advantage of utilizing the Tongueflag reservoirs as regulating basins, and so reducing the capacity of the main canal from 1,200 to 600 cubic feet per second and thus materially reducing the cost of the heavy cut east of the Highwood river and also the drop to Frank Lake reservoir. An additional advantage is gained by the country at large lying below the present intake, in that, with the present intake the possibility of land flooding in times of high water is practically eliminated.

The cost of the reduction in the size of the main canal, however, appears to be excessive, and it is quite possible that the cost of the project might be materially reduced by relocating the intake at the point where the main canal at present crosses the Highwood river by flume, and constructing a 1,200 cubic feet per second canal from that point to Frank Lake reservoir. This latter diversion would involve additional headworks in the form of a weir to raise the elevation of the water surface in the river, and further investigation of the river will probably be required in order to determine whether or not this would cause damage through flooding.

The lower diversion would reduce the present total reservoir storage capacity by some 16,000 acre-feet, but this amount if found to be required could be obtained in Frank Lake reservoir by increasing the height of the proposed dam.

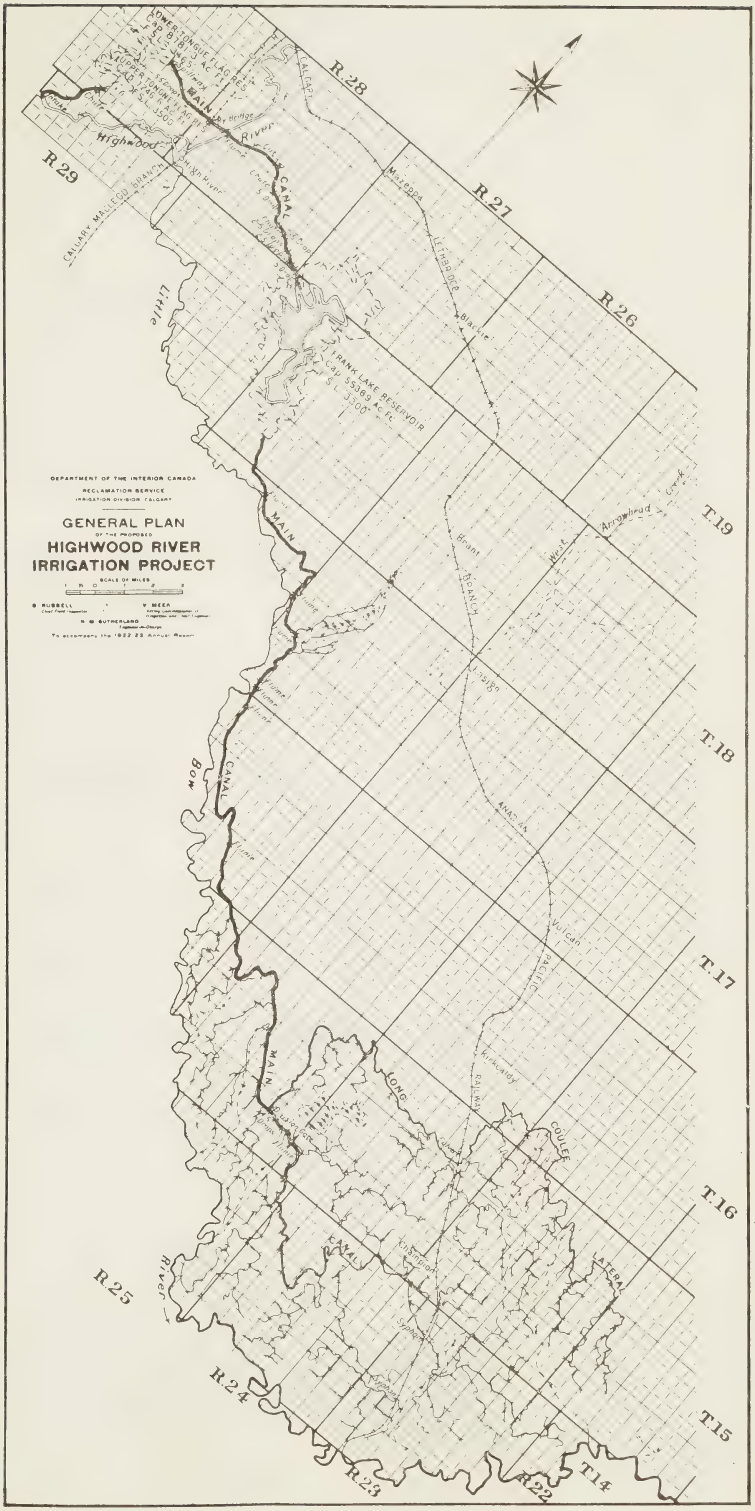
ESTIMATE OF COST—HIGHWOOD RIVER PROJECT

Headworks—		
Concrete (plain) 317 cu. yds. at $19.50	$ 6,182	
Concrete (rein.) 417 cu. yds. at $27.50	11,468	
Gates, etc.	3,000	
Piled groin 100 ft. at $20.00	2,000	$ 22,650
Upper Tongueflag Reservoir—		
Embankment 16,600 cu. yds. at $0.45	74,700	
Embankment 9,600 cu. yds. at $0.24	2,304	
Stripping, 21, 240 sq. yds. at $0.15	3,186	
Riprap, 15,860 sq. yds. at $2.00	31,720	
Concrete (rein.) 1,226 cu. yds. at $27.50	33,715	
Concrete (plain) 36 cu. yds. at $19.50	702	
Gates, flashboards, etc.	3,450	
Land damages, 568 acres at $30.00	17,040	166,817
Lower Tongueflag Reservoir—		
Embankment, 179,900 cu. yds. at $0.45	$ 80,955	
Stripping, 44,750 sq. yds. at $0.15	6,711	
Riprap, 25,900 sq. yds. at $2.00	51,800	
Concrete (rein.) 781 cu. yds. at $27.50	21,478	
Concrete (plain) 36 cu. yds. at $19.50	702	
Gates, flashboards, etc.	3,450	
Land damages, 455 acres at $20.00	9,100	174,196
Frank Lake Reservoir—		
Embankment, 6,100 cu. yds. at $0.45	$ 2,745	
Stripping, 4,360 sq. yds. at $0.15	654	
Riprap, 2,340 square yds. at $2.00	4,680	
Concrete (rein.) 400 cu. yds. at $27.50	11,000	
Concrete (plain) 42 cu. yds. at $19.50	819	
Gates, etc.	2,000	
Excavation of inside channel, 55,000 cu. yds. at $0.24	13,200	
Land damages, 4,216 acres at $25.00	105,400	140,498
Spillway below Tongueflag Reservoir—		
Reference plan 432		6,675
Railway Crossing Near High River—		
Steel span, 60,000 lbs. at $0.10	$ 6,000	
Piling, 280 lin. ft. at $1.00	280	
Concrete (plain) 84 cu. yds. at $19.50	1,638	
Excavation, 84 cu. yds. at $0.50	42	
Temporary track diversion	200	8,160

ESTIMATE OF COST HIGHWOOD RIVER PROJECT—Continued

Highwood River Crossing—		
Timber flume, 130,000 F.B.M., at $75.00	$ 9,750	
Piling, 1,300 lin. ft. at $0.85	1,105	
Concrete (plain) 135 cu. yds. at $19.50	2,633	
Concrete (rein.) 91 cu. yds. at $27.50	2,503	
2–100′ steel spans, 270,000 lbs., at $0.10	27,000	
		42,991
Drops and Chutes—Main Canal—		
Concrete (rein.) 2,210 cu. yds. at $27.50	$ 60,775	
Riprap, 3,400 sq. yds. at $2.00	6,800	
Excavation, 5,000 cu. yds. at $0.24	1,200	
Piling, 1,200 lin. ft. at $0.85	1,020	
		69,795
Flumes—Main Canal—		
Timber, 540,600 F.B.M. at $75.00	$ 40,545	
Piling, 8,540 lin. ft., at $0.85	7,259	
Concrete (rein.), 640 cu. yds. at $27.50	17,600	
		65,404
Long Coulee Crossing—		
Timber (flume) 325,500 F.B.M. at $75.00	$ 24,413	
Piles, 3,400 lin. ft. at $0.85	2,890	
Concrete (rein.) inlet and outlet—62 cu. yds. at $27.50	1,705	
Concrete drops, 260 cu. yds. at $27.50	7,150	
Excavation, 27,530 cu. yds. at $0.24	6,607	
Embankment, 127,240 cu. yds. at $0.24	30,538	
		73,303
*Division Gates in 11-15-25-*W. *4th M.*—		
Concrete (rein.) 148 cu. yds. at $27.50	$ 4,070	
Riprap, 170 sq. yds. at $2.00	340	
Gates, etc	2,244	
Excavation and back-fill	136	
		6,790
Railway syphons		3,444
Excavation—		
Main Canal, 2,544,705 cu. yds. at $0.24	$ 610,710	
Distributaries, 665,415 cu. yds. at $0.24	159,700	
		770,410
General Timber Construction—		
Main Canal, 85,310 F.B.M. at $80.00	$ 6,825	
Distributaries, 999,070 F.B.M. at $80.00	79,926	
		86,751
General Concrete Construction—		
Concrete (rein.) in outlets	$ 9,361	
Small concrete drops	7,000	
Riprap, concrete pipe, etc	4,488	
		20,846
Right of Way—		
Main Canal—479·28 acres at $30	$ 14,379	
260·60 acres at $15	3,909	
Distributaries, 752·9 acres at $30	22,587	
Road diversion in 15-29-28-W. 4th M	259	
		41,134
Telephone—54·5 M. at $275		14,988
Fencing—97·2 M. at $350		34,020
Highway bridges		51,955
Total		$ 1,800,830
Plus 15% to cover engineering and contingencies		270,125
Total		$ 2,070,955

Total irrigable area, 52,435 acres.
Cost per acre, $39.50.


DEPARTMENT OF THE INTERIOR CANADA
RECLAMATION SERVICE
IRRIGATION DIVISION CALGARY
GENERAL PLAN
OF THE PROPOSED
HIGHWOOD RIVER
IRRIGATION PROJECT
SCALE OF MILES
1 ½ 0 1 2 3
RUSSELL
Chief Field Inspector
SUTHERLAND
To accompany the 1922 23 Annual Report
FRANK LAKE RESERVOIR
Cap 55389 Ac Ft
F.S.L. 3300
MAIN
CANAL
Highwood
River
Little
Bow
River
LONG
COULEE
LATERAL
Arrowhead
Creek
West
BRANCH
Mazeppa
Blackie
Ensign
Vulcan
Kirkcaldy
Champion
CALGARY MACLEOD BRANCH
LETHBRIDGE
PACIFIC
RAILWAY
R.29
R.28
R.27
R.26
R.25
R.24
R.23
R.22
T.19
T.18
T.17
T.16
T.15
T.14

WATER SUPPLY STUDY—HIGHWOOD RIVER PROJECT—FROM OCTOBER, 1917, TO SEPTEMBER, 1921

NOTE—This study assumes reservoirs to be empty at start, October 1, 1917. With 10,000 acre-feet in storage at that date, there would be practically no deficiency during period covered by study. As it is, a shortage occurs in only one month—September, 1919. If land requirements were supplied in this month and evaporation of 936 acre-feet allowed from dead storage in Frank Lake reservoir, deficiency would be 8,113+1, 236+936=10,285 acre-feet.

Year	Month	Acre-feet Available at Intake	Acre-feet actually taken into Canal	Waste at River	Upper Tongueflag Reservoir, Capacity, 7,243 Ac.-ft.				Lower Tongueflag Reservoir, Capacity, 8,781 Ac.-ft.					Frank Lake Reservoir, Capacity, 55,369 Ac.-ft.				
					Net into Reservoir from Canal	Seepage and Evaporation	Out to Lower Tongueflag Reservoir	In Reserve at end of Month	Acre-feet from Upper Tongueflag Reservoir	Natural Run off Acre-feet	Seepage and Evaporation	Out to Frank Lake Reservoir	In Reservoir at end of Month	Acre-Feet from Lower Tongueflag Reservoir	Natural Run off Acre-feet	Seepage and Evaporation	To Land, 52,461 Acres	In Reservoir at end of Month
1917	October	6,200	6,200		6,174		6,174		6,174			6,174		5,994		1,600		4,394
	November	900	900		896		896		896			896		870		760		4,504
	December															760		3,744
1918	January															740		3,004
	February															740		2,264
	March									600		600		582	1,800	740		3,906
	April	174	174		173		173		173	1,200		1,373		1,333	3,600	1,500		7,339
	May	23,862	23,862		23,764		23,764		23,764	360		24,124		23,424	1,080	2,200	8,112	21,531
	June	46,732	46,732		46,538	70	44,421	2,047	44,421	240	280	35,600	8,781	34,567	720	3,640	24,338	28,840
	July	19,994	19,994		19,911	90	21,868		21,868		360	30,289		29,410		4,860	24,338	29,052
	August	16,308	16,308		16,240		16,240		16,240			16,240		15,769		5,200	16,224	23,397
	September	708	708		705		705		705			705		685		2,350	8,113	13,619
	Total	114,878	114,878		114,401	160	114,241		114,241	2,400	640	116,001		112,634	7,200	25,090	81,125	13,619
1918	October	3,858	3,858		3,842		3,842		3,842			3,842		3,731		1,760		15,590
	November															900		14,690
	December															880		13,810
1919	January															860		12,950
	February															850		12,100
	March									300		300		291	750	850		12,291
	April	622	622		619		619		619	600		1,219		1,184	1,500	1,720		13,255
	May	27,640	27,640		27,525		27,525		27,525	180		27,705		26,900	450	2,300	8,112	30,193
	June	28,788	28,788		28,668		28,668		28,668	120		28,788		27,953	300	3,850	24,338	30,258
	July	4,218	4,218		4,200		4,200		4,200			4,200		4,188		4,320	24,338	5,788
	August	13,132	13,132		13,078		13,078		13,078			13,078		12,700		3,500	16,224	−1,236
	September	54	54		54		54		54			54		52		1,652		−2,836
	Total	78,312	78,312		77,986		77,986		77,986	1,200		79,186		76,999	3,000	23,442	73,012	−2,836

1919	October	1,372	1,372		1,366		1,366		1,366			1,366		1,326		1,332		−2,842
	November															660		−3,502
	December															666		−4,168
1920	January															660		−4,828
	February															660		−5,488
	March									1,000		1,000		971	3,000	660		−2,177
	April	20,358	20,358		20,274		20,274		20,274	2,000		22,274		21,627	6,000	1,720		23,730
	May	59,126	53,030	6,096	52,809	275	45,291	7,243	45,291	600	210	36,900	8,781	35,827	1,800	3,200	8,112	50,045
	June	54,886	35,128	19,758	34,982	370	34,612	7,243	34,612	400	295	34,717	8,781	33,712	1,200	5,250	24,338	55,369
	July	66,052	33,130	32,922	32,990	495	32,495	7,243	32,495		477	32,018	8,781	31,088		6,750	24,338	55,369
	August	13,428	13,428		13,372	275	20,340		20,340		430	24,435	4,256	23,724		7,500	16,224	55,369
	September										100	4,156		4,035		3,600	8,113	47,691
	Total	215,222	156,446	58,776	155,793	1,415	154,378		154,378	4,000	1,512	156,866		152,310	12,000	32,658	81,125	47,691
1920	October	2,492	2,492		2,482		2,482		2,482			2,482		2,410		2,800		47,301
	November															1,400		45,901
	December															1,400		44,501
1921	January															1,360		43,141
	February															1,350		41,791
	March									600		600		583	1,400	1,300		42,474
	April	4,850	4,850		4,830		4,830		4,830	1,200		6,030		5,855	2,800	2,720		48,409
	May	38,030	34,639	3,391	34,549	275	27,031	7,243	27,031	360	210	18,400	8,781	17,862	840	3,630	8,112	55,369
	June	63,596	30,467	33,129	30,340	385	29,955	7,243	29,955	240	295	29,900	8,781	29,028	560	5,250	24,338	55,369
	July	22,182	22,182		22,090	190	29,143		29,143		378	32,018	5,528	31,088		6,750	24,338	55,369
	August	5,020	5,020		4,999		4,999		4,999		210	10,317		10,020		6,500	16,224	42,665
	September															3,000	8,113	31,552
	Total	136,170	99,650	36,520	99,290	850	98,440		98,440	2,400	1,093	99,747		96,846	5,600	37,460	81,125	31,552

WATER SUPPLY STUDY—HIGHWOOD RIVER PROJECT FROM OCTOBER, 1917, TO SEPTEMBER, 1921—*Concluded*

CANAL CAPACITIES

Canal	C.F.S.	Acre-feet 30 Days	Acre-feet 31 Days	Canal	C.F.S.	Acre-feet 30 Days	Acre-feet 31 Days	Canal	C.F.S.	Acre-feet 30 Days	Acre-feet 31 Days
H.G. to U.T.F. Res.	1,200	71,300	73,900	L.T.F. to Frank Lake Res.	600	35,600	36,900	Frank Lake to Land.	585	34,900	35,900

LOSS IN CANALS

Canal	Per cent Loss	Canal	Per cent Loss
H.W. River to U.T.F Reservoir..............	0·415	Lower T.F. Reservoir to F. Lake Res.....	2·902

TABLE OF RESERVOIR LOSSES

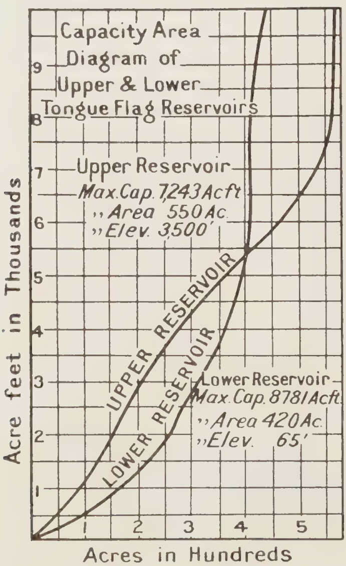
Month	Evaporation	Seepage	Total	Month	Evaporation	Seepage	Total	Month	Evaporation	Seepage	Total
October.......	.. 0·2	0·2	0·4	February....	....	0·2	0·2	May.......	0·3	0·2	0·5
November....	....	0·2	0·2	March.......	....	0·2	0·2	June.......	0·5	0·2	0·7
December.....	....	0·2	0·2	April (1-15)	0·1	0·1	0·2	July.......	0·7	0·2	0·9
January.......	....	0·2	0·2	April (16-30)	0·1	0·1	0·2	August.....	0·8	0·2	1·0
								September	0·3	0·2	0·5
								Total feet per annum			5·4

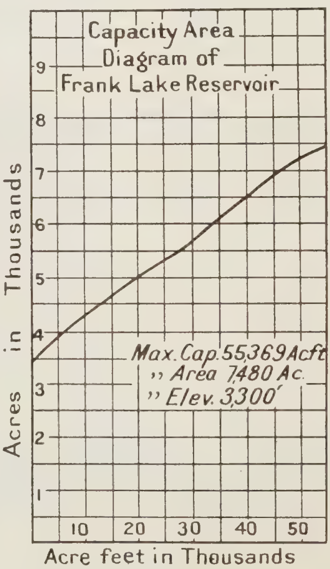
Available Run-off in Acre-feet to Lower Tongueflag Reservoir (Estimated)

Month	1918	1919	1920	1921
March..................	600	300	1,000	600
April...................	1,200	600	2,000	1,200
May.....................	360	180	600	360
June....................	240	120	400	240
Total.............	2,400	1,200	4,000	2,400

Run-off in Acre-feet into Frank Lake Reservoir

Month	1918	1919	1920	1921
March....................	1,800	750	3,000	1,400
April.....................	3,600	1,500	6,000	2,800
May.......................	1,080	450	1,800	840
June......................	720	300	1,200	560
Total..............	7,200	3,000	12,000	5,600





MAGRATH IRRIGATION PROJECT

During 1922 the residents of the western portion of the Southern Irrigation district, lying between Pothole river and the St. Mary river to the north of the main Alberta Railway & Irrigation Company's canal in townships 5, 6 and 7, ranges 21, 22 and 23, west of the 4th meridian decided to withdraw from the parent district and form a new district under the 1920 provincial Act.

The proposed district covers the following three distinct tracts; the area served under the constructed Magrath lateral in township 5, range 22, west of the 4th meridian; the North Magrath tract, in townships 6 and 7, ranges 21 and 22, which is served by an extension of the existing Magrath lateral, plane-tabled in 1920, and the West Magrath tract, in townships 4, 5 and 6, ranges 22 and 23, west of the 4th meridian. The last mentioned area was plane-tabled last season following a reconnaissance survey which proved its feasibility.

The maximum area which could be irrigated in the district is as follows:—

	acres
Constructed A.R. & I. Magrath tract (approximately 1,900 under water agreements)	5,000
North Magrath tract	15,406
West Magrath tract	10,266
Total	30,672

The district has arrived at a tentative agreement with the Canadian Pacific Railway Company by which the company will sell 100 cubic second-feet of water or less, in addition to the 12 second-feet already supplied, to be delivered into the ditches of the district. The company will also make an annual charge per second-foot to cover a proportion of the cost of operation and maintenance, and the new district will take over the old water-users and pay to the company a proportion of the amount collected under the existing agreements.

From calculations made it has been decided that the maximum area which 112 cubic second-feet continuous flow or its equivalent could supply, amounts to approximately 18,830 acres.

To find out how much irrigable area each individual land owner wished to have included in the district, plans were forwarded to interested parties who made a canvass of the area, and marked on each quarter-section the actual area of irrigable land to be included. A canal system was then designed and an estimate of cost prepared to cover only the area applied for, which is as follows:

	acres
New area under Magrath lateral in tp. 5, rge. 22	1,045·0
West Magrath system	6,027·5
North Magrath system	5,457·1
Total	12,529·6

Besides supplying the above area sufficient water would have to be diverted to serve the existing water agreements under the Magrath lateral, amounting to approximately 1,900 acres. The total area therefore to be supplied is 14,430 acres.

Canal Design.—The main canals and laterals have been designed to irrigate 50 per cent of the total area six inches in depth in a 15-day period, in accordance with the usual practice. Seepage losses were estimated at 6 second-feet per million square feet of wetted area.

Main Canals and Distributary Systems.—The West Magrath tract of the district, amounting to 6,027·5 acres, is served from a main distributary which takes off from the main Alberta Railway & Irrigation Company's canal about 400 feet above the 17-foot drop in the SW. ¼ of section 28, township 4, range 23, west of the 4th meridian. The discharge of this distributary at point of diversion is 68 second-feet, of which 14 second-feet, or approximately 20·6 per cent, is to allow for losses in the system. There are no difficulties in connection with the construction of the proposed works to supply this tract. On account of the steep general slope of the country to the northeast, a great many wooden drops are required, and besides these structures a syphon under the Canadian

Pacific railway, in section 33, township 4, range 23, a short flume in section 23, township 5, range 23, and a timber chute 225 feet long in a 4-by 2-foot ditch in section 1, township 6, range 23, will be required. The soil of the land commanded is mostly of a light clay loam well drained by natural water courses. There are no signs of alkali on the surface.

To serve the North Magrath tract and the existing water-users and extensions in township 5, range 22, it is proposed to enlarge and extend the existing Magrath lateral, which takes-off from the main Alberta Railway & Irrigation Company's canal in the SW. ¼ of section 9, township 5, range 22, west of the 4th meridian. This lateral, which at present carries approximately twelve second-feet, is to be constructed of sufficient size to divert 95·4 second-feet, of which 25·4, or approximately 26·6 per cent is to cover the estimated losses. The 8,402 irrigable acres commanded, which include the 1,900 acres under water agreements are ideal for irrigation. The soil is good, the drainage is adequate, and any parcels affected by alkali have been cut out. The main structures required on this system will be a 40-inch wood-stave syphon, 1,160 feet long in the NW. ¼ section 16, township 6, range 22, a syphon under the railway in the SW. ¼ section 21, township 5, range 22, and some sidehill flumes on the enlargement of the existing lateral.

Water Requirements and Supply.—Assuming an 80 per cent irrigation factor and a duty of 1·5 acre-feet on the new area to be developed in the district, and 100 per cent factor and a duty of two acre-feet on the existing agreements, the actual amount of water including losses required to be diverted from the Alberta Railway & Irrigation Company's system yearly to supply the total area amounts to 24,918 acre-feet, which equals a continuous flow of approximately eighty-three second-feet for the duration of the irrigation period of 163 days.

The monthly requirements using these factors will be as follows:—

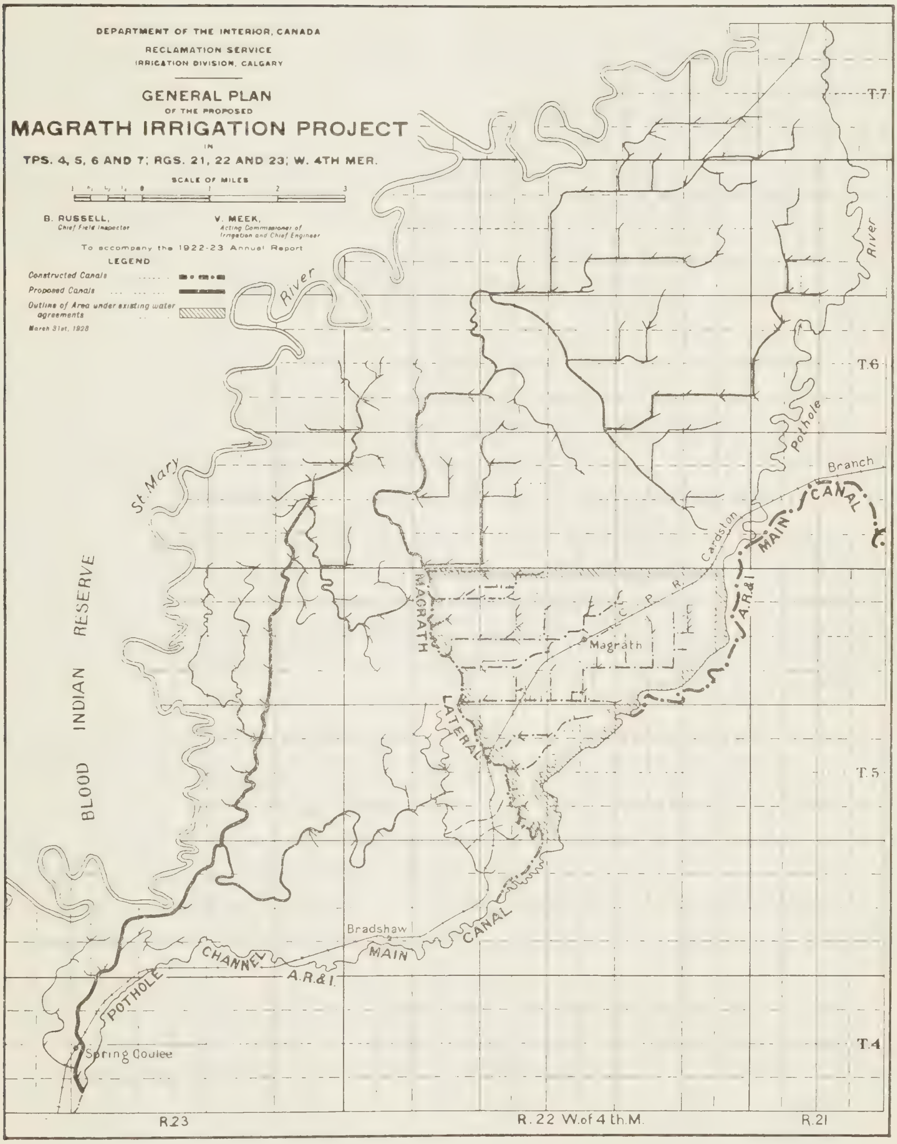
May—	10% 2,492 ac.-ft.	equals	40·6	c.f.s.	continuous flow.
June—	30% 7,475	" "	125·9	"	"
July—	25% 6,230	" "	101·5	"	"
Aug.—	15% 3,737	" "	60·9	"	"
Sept.—	10% 2,492	" "	42·0	"	"
Oct.—	10% 2,492	" "	40·6	"	"

From a study of the hydrographs of the St. Mary river for the years 1911 to 1920, it is found that there is sufficient water available in Canada's share of the St. Mary river to cover all requirements except in the year 1918-19. Although this year produced the minimum discharge on record, there is an excess available until near the end of June to carry the whole area over the critical period.

Estimated Cost—

The following is the estimated construction cost for all works in connection with the district, except the turnout structures from the main Alberta Railway & Irrigation Company's canal:—

North and West Magrath Tracts—		
Excavation, 247,064 cu. yds. at $0.24	$ 59,295	
Timber, 404,000 F.B.M. at $1.00	40,400	
Riprap, 120 sq. yds. at $2.00	240	
Concrete (rein.) 20 cu. yds. at $27.50	550	
Pipe, 12 ins. x 82 ft., at $2.05	168	
Pipe, 18 ins. x 28 ft., at $3.20	90	
Right of way, 295 acres at $25.00	7,375	
Concrete drops	7,760	
Syphon, NW. 16–6–22	8,000	
Chute, 1–6–23	540	
Flume, 23–5–23	1,053	
Railway syphon (West Magrath system)	550	
		$ 126,023
A. R. & I. Enlargement—		
Excavation, 52,880 cu. yds. at $0.24	$ 12,691	
Flume, 600 ft. long	2,520	
Flume, 200 ft. long	1,230	
Railway syphon	680	
Lateral system, 1,045 acres at $1.00	1,045	
		$ 18,166
		$144,189
10 per cent engineering, etc		14,419
Total		$158,608


DEPARTMENT OF THE INTERIOR, CANADA
RECLAMATION SERVICE
IRRIGATION DIVISION, CALGARY
GENERAL PLAN
OF THE PROPOSED
MAGRATH IRRIGATION PROJECT
IN
TPS. 4, 5, 6 AND 7; RGS. 21, 22 AND 23; W. 4TH MER.
SCALE OF MILES
0 1 2 3
B. RUSSELL,
Chief Field Inspector
V. MEEK,
Acting Commissioner of Irrigation and Chief Engineer
To accompany the 1922-23 Annual Report
LEGEND
Constructed Canals
Proposed Canals
Outline of Area under existing water agreements
March 31st, 1923
River
St. Mary
BLOOD INDIAN RESERVE
River
Pothole
Branch
Cardston
MAIN CANAL
A.R.&I.
MAGRATH
LATERAL
Magrath
Bradshaw
MAIN CANAL
POTHOLE CHANNEL
A.R.&I.
Spring Coulee
T.7
T.6
T.5
T.4
R.23
R.22 W. of 4 th.M.
R.21

Area Developed—

A. R. & I. enlargement	1,045·0 acres
North Magrath tract	6,027·5 "
West Magrath tract	5,457·1 "
	12,529·6 acres

Cost per acre, $\frac{\$158,608.00}{12,529\cdot6}$ equals $12 66

Plans and Profiles.—The following plans have been completed in the office in the required form for filing by the district:—

1. A general plan showing the boundaries of the proposed project and the location of all canals, scale 1 inch to 1 mile.
2. Topographic maps of the North and West Magrath tracts, scale 1 inch to 2,000 feet.
3. Structure map showing the irrigable areas in each quarter-section and the location of all canals and structures, scale 1 inch to 2,000 feet.
4. Profiles of all canals over 25 second-feet capacity.

MOUNTAIN VIEW IRRIGATION PROJECT

General.—As a result of petitions submitted in the early spring by residents of the Mountain View district, in townships 2 and 3, ranges 27 and 28, west of the 4th meridian, a reconnaissance was made during the 1922 field season by S. H. Hawkins, for the purpose of determining the possibilities of irrigating this area.

The result of this reconnaissance showed the area to be suitable for irrigation as to topography, soil, and drainage, and therefore acting upon instructions from this office, Mr. Hawkins made a detailed survey of the scheme which included a traverse of the main canals and a plane-table and stadia topography-survey of all the lands commanded. Complete plans, profiles, and cost estimates have since been prepared.

Canal Design.—The main canals and laterals have been designed of a sufficient size to irrigate 80 per cent of the total area 6 inches in depth in a fifteen-day period. Seepage losses were estimated at 6 second-feet per million square feet of wetted area. The total irrigable area under the ditch is 2,605 acres, which includes 100 acres of the licensed scheme of Mr. John West, in the SW. ¼ of section 4, township 2, range 28. As the main canal of the proposed Mountain View scheme crosses Mr. West's existing ditch, provision has been made for a gate by which his land could be served. This area has not, however, been included in the district in estimating the cost per irrigable acre.

Water Supply.—On account of the small irrigable area on the majority of quarter-sections in the scheme, and also that the irrigation of native hay will be carried out extensively, a 90 per cent irrigation factor has been used. Conveyance losses have been computed as 16 per cent of the gross diversion.

Total irrigable area	2,605 acres
90 per cent irrigation factor	2,345 acres
2,345 acres at 18″ duty	3,517 acre-feet
Conveyance loss	16 per cent of gross
Gross requirements	4,187 acre-feet yearly

This quantity of water will be applied approximately in a normal season as follows:—

May—	20%, equals	837 acre-feet
June—	35%, "	1,466 "
July—	30%, "	1,256 "
Aug.—	10%, "	419 "
Sept.—	5%, "	209 "
	Total yearly	4,187 acre-feet

A study has been made of the available water supply in the Belly river to serve this area, which shows that after providing for all prior rights, there would have been an ample supply in every year from 1912 to 1922 with the exception of 1918 and 1919. In these two dry years a shortage occurred near the end of July which amounted to approximately 200 acre-feet in 1918 and 695 acre-feet in 1919. There is always ample water available in the river up to the middle of July, and a small shortage after that date in exceptionally dry years would not be serious, as it would not affect the chief object of the scheme, that is, the growing of winter feed.

In the development of the scheme it would be quite possible to utilize Driggs lake as a storage reservoir, the cost of which would be $16,000, or, approximately, $6.50 per irrigable acre for its construction. The inclusion of this reservoir in the scheme would take care of the small shortage which would occur in exceptionally dry years, the benefit received, however, does not warrant its inclusion.

Main Canal and Distributary Systems.—The required water supply is to be diverted from the Belly river in the SW. ¼ section 33, township 1, range 28, west of the 4th meridian, by a timber headgate, a weir not being required. The main canal, after passing through a short cut at the headgate, follows a falling contour to a natural channel in the NE. ¼ of section 9, township 2, range 28, west of the 4th meridian, which leads into Driggs lake. The distributary system is of simple design. A high level lateral (lateral B) is led from the north end of the lake through a short cut to command 758 acres of land in the southern part of the scheme. This land is generally rough and of steep slopes; the swales and low spots are suitable for hay growing, which is the chief requisite of the ranchers interested in the scheme. Mami creek channel is used to carry water from Driggs lake to the headgate of the low-level lateral (lateral A) which takes-off from Mami creek in the SW. ¼ of section 19, township 2, range 27, west of the 4th meridian. This lateral irrigates 1,747 acres of land in the northern part of the scheme, and of this area that portion north of sections 25 and 26, township 2, range 28, west of the 4th meridian, has smooth slopes, 100 per cent irrigable where commanded, and is at present under cultivation.

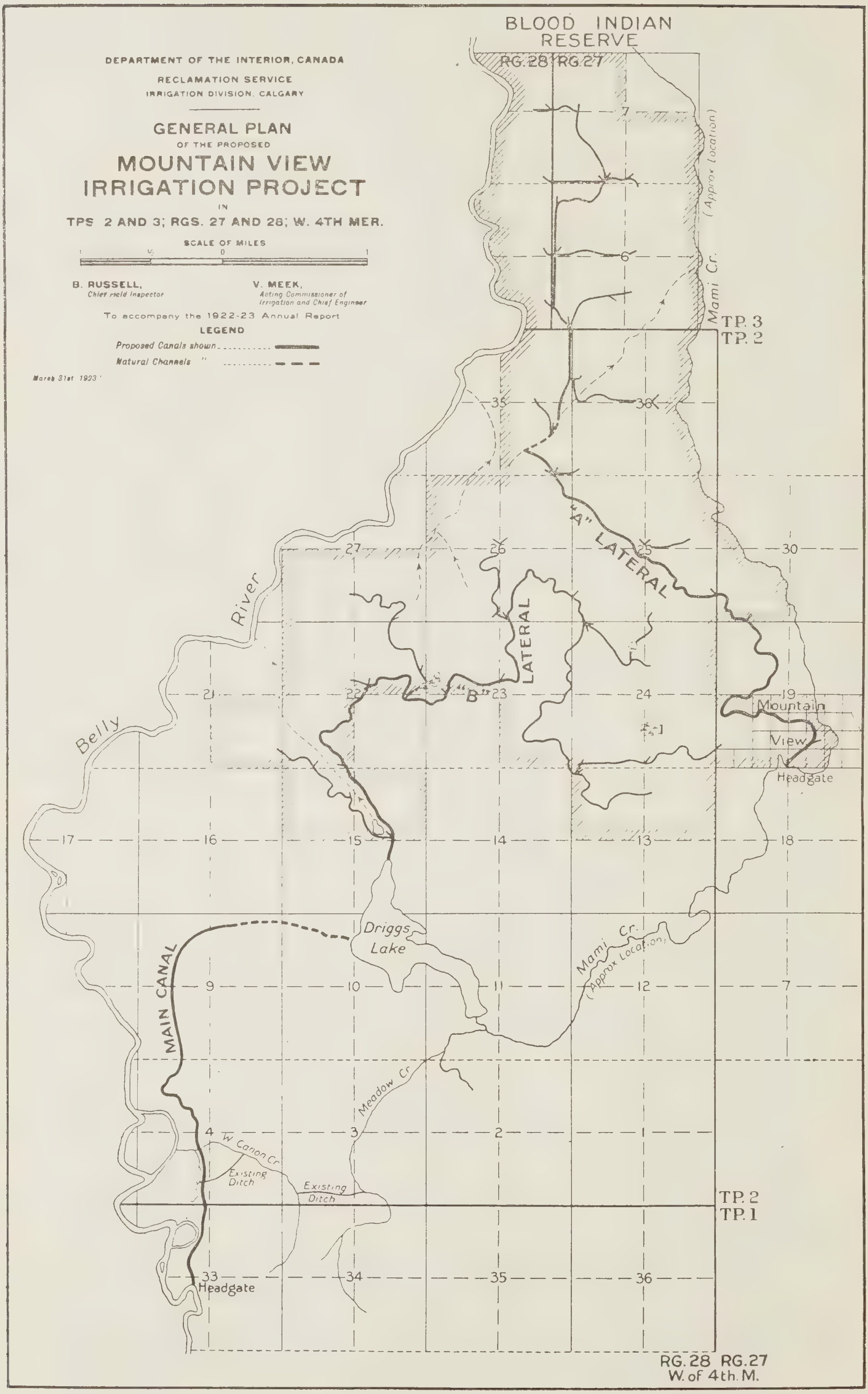
ESTIMATE OF COST OF PROPOSED MOUNTAIN VIEW IRRIGATION PROJECT

Main Canal—		
Headgate on Belly river	$ 828 00	
Excavation, 15,400 cu. yds. at $0.24	3,696 00	
Right of way, 11·6 acres at $25.00	290 00	
Structures	541 40	
		$ 5,355 40
High Level Lateral (Lateral B) and Distributary System—		
Excavation, 20,346 cu. yds. at $0.24	$ 4,904 65	
Right of way, 31·68 acres at $25.00	792 00	
Structures (timber)	4,341 00	
		10,037 65
Low Level Lateral (Lateral A) and Distributary System—		
Excavation, 28,175 cu. yds. at $0.24	$ 6,762 00	
Right of way, 31·86 acres at $25.00	796 50	
Structures (riprap, etc.)	7,754 40	
		15,312 90
		$30,705 95
Plus 10% engineering, etc		3,070 60
Total		$33,776 55

Total area served 2,505 acres.
Cost per acre, $13.48.

Plans and Profiles.—The following plans have been completed in the required form for filing by the district:—

1. A general plan showing the boundaries of the proposed project and the location of all canals—Scale 1 inch to one-half mile.
2. Topographic map of the proposed project—Scale 1 inch to 1,000 feet.
3. Structural map showing the irrigable areas in each quarter-section and the location of all canals and structures—Scale 1 inch to 1,000 feet.
4. Profiles of all canals over 25 second-feet capacity.


DEPARTMENT OF THE INTERIOR, CANADA
RECLAMATION SERVICE
IRRIGATION DIVISION, CALGARY
GENERAL PLAN
OF THE PROPOSED
MOUNTAIN VIEW
IRRIGATION PROJECT
IN
TPS 2 AND 3; RGS. 27 AND 28; W. 4TH MER.
SCALE OF MILES
B. RUSSELL,
Chief Field Inspector
V. MEEK,
Acting Commissioner of Irrigation and Chief Engineer
To accompany the 1922-23 Annual Report
LEGEND
Proposed Canals shown
Natural Channels "
March 31st 1923
BLOOD INDIAN
RESERVE
RG.28 RG.27
(Approx Location)
Mami Cr.
TP. 3
TP. 2
"A" LATERAL
"B" LATERAL
Belly River
Mountain
View
Headgate
Driggs
Lake
Mami Cr.
(Approx Location)
MAIN CANAL
Meadow Cr.
W. Canon Cr.
Existing Ditch
Existing Ditch
TP. 2
TP. 1
Headgate
RG. 28 RG. 27
W. of 4th. M.

LETHBRIDGE SOUTHEAST PROJECT

During the season, surveys were made of a number of extensions and revisions of this project. These surveys were carried out by a small party in charge of S. H. Hawkins. The field data have since been worked up in the office and the estimates of that project revised accordingly. Plane-table surveys were completed of what is known as the Writing-on-Stone district consisting of an isolated tract of land in townships 2 and 3, ranges 13 and 14, between Verdigris coulee and Milk river. In order to reach this area it is proposed to cross Verdigris coulee from the Milk River district, in section 22, township 2, range 14, by means of an inverted syphon 2,600 feet in length under a maximum head of 165 feet. The area which can be served from this crossing is 12,300 acres, and the estimated cost of the necessary distributary system $10.08 per irrigable acre. Since this district includes some very excellent lands and the construction cost is very reasonable, it has been included in the Lethbridge Southeast project, and the estimates and plans of that project revised to include it.

In order to irrigate lands in the Milk River, Warner, and Writing-on-Stone districts it is necessary to divert a quantity of water from the Milk river, and for this purpose it is proposed to reconstruct the headworks and repair the canal built from that river in the early days by the Alberta Railway & Irrigation Company. For estimating purposes it was necessary to cross-section fourteen miles of this canal and make a detailed survey of the headworks. This work was completed during the season, a cost estimate compiled, and the plans and estimates of the Lethbridge Southeast project revised accordingly.

Horsefly lake in township 9, range 16, west of the 4th meridian is a sump into which the waste water from adjoining irrigable lands will drain. In previous estimates provision was made to drain this lake through a coulee which heads near the east end of the lake and runs in a northeasterly direction to Forty Mile coulee. On account of the great length of drain required the possibility of an alternative route from the northwest end to a point in the proposed Big Bend lateral was investigated in the field and found to be feasible. By redesigning certain canals of the Lethbridge Southeast project with this in view a saving of something like $60,000 has been effected and the estimates have been revised in this respect.

A detailed survey was made for an inlet canal to Chin reservoir. This reservoir is now fed mainly by a canal which runs freely down a coulee to the southeast end. When this reservoir is developed to full capacity, on account of the large quantity of water which will have to be handled and the excessive fall, it will be necessary to control the flow by means of structures. From the surveys made, detailed plans and estimates have been prepared and included in the Lethbridge Southeast project.

For a number of years some farmers occupying lands in townships 4, 5 and 6, in ranges 22 and 23, west of the 4th meridian, above the existing Magrath lateral, have been agitating for surveys to determine the possibilities of reaching these lands by a diversion from the main canal of the Alberta Railway & Irrigation Company, at some point near Spring coulee before the water is dropped into the natural channel of West Pothole coulee. A reconnaissance made early in the season proved the possibility of such a scheme, and later in the season a party was transferred to this area to make the necessary surveys. A traverse for a diversion canal was made starting from a point on the main canal about one-half mile south of the town of Spring Coulee, the controlling elevation being a saddle in section 14, township 5, range 23. Plane-table surveys were made of the area thus commanded, and plans and cost estimates have since been compiled. The area which can be served is 10,266 acres, and the estimated cost of the distributary system about $11 per irrigable acre. The lands have been included in the Lethbridge Southeast project, and the necessary revisions made to the plans and estimates.

Since this survey was made the Magrath district, referred to in greater detail elsewhere in this report, has been organized. Plans and cost estimates have been prepared, and it is expected that such a scheme will be constructed in the near future.

At the time of making the above surveys, a line to revise the location of one of the main canals of the Lethbridge Southeast project was made in order to avoid two railway crossings just west of the town of Bradshaw. Estimates of cost of this revision have since been made and are included in the revised estimates of the Lethbridge Southeast project.

As a result of petitions received from a number of farmers in the vicinity of Mountain View, a survey was made to determine the possibility of irrigating from the Belly river, certain lands in townships 2 and 3, ranges 27 and 28, between the Belly river and Mami creek. From the proposed point of intake in the SW. ¼ of section 33, township 1, range 28, a canal was run out to the irrigable area and plane-table surveys made of the lands thus commanded. A detailed report upon this project is given elsewhere.

Since it is very probable that this scheme—the Mountain View project—will be constructed in the near future without any Government guarantee of bonds it has not been included in the Lethbridge Southeast project. These lands, however, are under the main supply canals of this project and could be irrigated from it. Furthermore, since the intake and a portion of the main canal of the Mountain View project would be flooded out by the construction of the proposed Belly River reservoir, it would be necessary to provide this district with water if the Lethbridge Southeast project were constructed.

CONDENSED ESTIMATE OF COST OF PROPOSED LETHBRIDGE SOUTHEAST PROJECT

Item	Estimated Cost plus 10% Engr.
	$ cts.
Waterton lake storage	960,382 90
Waterton river diversion canal	505,520 05
Belly river storage	766,243 00
Belly river diversion canal to Spring coulee	1,679,527 90
A.R. & I. main canal enlargement—Kimball to 6-5-22	666,877 85
West Magrath distributary system	113,253 75
Enlargement Magrath lateral and North Magrath system	172,664 80
Milk river reservoir feeder and South Magrath system	911,766 00
Milk river reservoir complete	711,288 20
Verdigris reservoir feeder and Middle coulee system	698,791 25
Verdigris reservoir complete	559,254 15
Milk river diversion canal, Warner, Milk river and Writing-on-Stone systems	713,581 40
Spillway canal, Verdigris reservoir to Milk river	106,601 50
East Verdigris main canal and Foremost, Pakowki and East Verdigris systems	1,695,639 40
Raymond reservoir feeder canal and South New Dayton system	137,099 25
Raymond reservoir complete	385,137 30
North New Dayton distributary system	279,485 20
Balancing canal and lateral system	169,667 40
A. R. & I. enlargement, Welling to Chin reservoir including extension of existing lateral system	1,521,711 80
Chin No. 1 lateral enlargement and Cameron ranch system	74,345 70
East Chin main canal and North Forty Mile, South Forty Mile, and East Chin systems	1,497,996 70
Chin reservoir complete (enlargement)	269,954 85
Enlargement of Taber system from Chin Butte Dam to 21-9-17 and Taber West system	206,502 40
Taber main canal enlargement from 21-9-17 and Purple springs and Big Bend systems	345,925 90
Main Burdett canal and distributary systems served including Horsefly Lake reservoir	681,088 65
	15,830,307 30
5 per cent contingencies for classification, etc	791,515 35
	$ 16,621,822 65

Total area developed—414,401 acres. Cost per acre—$40.11.

A tentative plan of the Lethbridge Southeast project was published in the Annual Report of 1921-22. Later studies, however, based on fuller data will necessitate some further changes in the layout as there shown.

RETLAW-LOMOND IRRIGATION PROJECT

In the year 1914, at the request of interested settlers, surveys were made of the district lying north of the Little Bow and Belly rivers in ranges 17, 18, 19 and 20, west of the 4th meridian, to determine the feasibility of diverting water,

primarily for domestic use, in the above area from the main canal of what is now the Canada Land & Irrigation Company. Also a reconnaissance of the whole area was made, and a system of canals located which would irrigate some 94,000 acres of land. From a domestic point of view the scheme was not considered feasible on account of the few settlers who would be benefited. This scheme was then known as the Sundial Irrigation and Water Supply project. The name has since been changed to the Retlaw-Lomond Irrigation project.

On account of there being a more assured water supply from the Oldman river to supply an area of this extent, a reconnaissance was made in 1915 to determine the possibility of extending what is now known as the Lethbridge Northern Irrigation project across the Little Bow river to serve these lands. It was found that although the crossing of the Little Bow river would be an expensive undertaking, such a scheme would be feasible, and more land would be commanded than by a diversion from the main canal of the Canada Land & Irrigation Company.

During the years 1915 and 1916 bumper crops were harvested in the district, and no further interest was taken in irrigation, but during the following period of dry years active interest again developed.

During the 1919 season preliminary surveys were made to determine more closely what area could be served to the northeast of the Little Bow river, and also to locate the several supply canals from the proposed Lethbridge Northern project. These surveys were made with the idea of irrigating forty acres to the quarter-section, and on this basis it was found that 58,000 acres could be served. If all the area possible were irrigated, it was estimated that the total would be about 100,000 acres. At this time a number of meetings were held throughout the district, and the residents were advised to unite with the Lethbridge Northern project, but no action was taken, and the petitions circulated were not widely signed, especially to the north of the Canada Land & Irrigation Company's main canal.

In the season of 1920 a reconnaissance was made to determine the feasibility of diverting the Highwood river into Lake MacGregor reservoir of the Canada Land & Irrigation Company's scheme, to supply the Retlaw-Lomond project with water. It was found that this would be quite feasible, but on account of the long length of flood canal necessary, and also as this canal would pass through some 80,000 acres of land which could be irrigated and needed the water, it was considered that the extension of this canal to serve the Retlaw-Lomond project was out of the question.

During the 1921 season a survey was carried out in this project to determine the possibility of irrigating certain high lands to the east of the Little Bow river in townships 12, 13, and 14, ranges 19 and 20, from the main canal of the Canada Land & Irrigation Company. From the surveys made, it was found that most of the high lands which could be reached from the Lethbridge Northern project by a crossing of the Little Bow river (1919 surveys) would be inaccessible from the canal system of the Canada Land & Irrigation Company. Besides the above work, during this year a field study was made of the Canada Land & Irrigation Company's main diversion canal from the Bow river and Lake MacGregor reservoir, with a view to the enlargement of these works to supply water to the Retlaw-Lomond project. Upon the completion of this work complete office studies of the available water supply from both the Bow and Oldman rivers were made, and also estimates of cost were prepared of the enlargement and extension of the Canada Land & Irrigation Company's main canal system and the Lethbridge Northern system to supply this area. From these studies the Bow river source of supply was found to be the more economical as far as the construction of the necessary works was concerned, but, on the other hand, the Oldman river was a better source of water supply.

In July, 1921, a petition signed by the majority of the landowners in the project was submitted to the Minister of Public Works for Alberta, requesting

the formation of an irrigation district. As a result complete plane-table surveys of all the area which could be commanded, either from the works of the Canada Land & Irrigation Company, or by an extension of the Lethbridge Northern project, were carried out by this branch during the 1922 field season.

The party consisted of five plane-tables with L. A. McGillivray in charge. Field-work was commenced on May 10 and completed on December 2. The total number of plane-table days included in that period was 752, in which time 227,730 acres of land were plane-tabled. Besides this work, 750 miles of levels were run, and 129 soil samples obtained and tested.

Since the close of the field season an office party has been engaged on the design and estimation of distributary systems to serve the maximum commanded area either under the Bow river or Oldman river sources of supply, and it is expected that this work will be completed in the near future.

SOUTH SASKATCHEWAN DIVERSION PROJECT

Resolutions passed by a number of municipalities in that district adjoining the Empress branch of the Canadian Pacific railway to the south of the South Saskatchewan river were early in the year directed to the Minister of the Interior, requesting that the Dominion Government undertake the necessary surveys to determine the possibility of pumping water for irrigation to suitable lands in this district. The plan suggested was to create sufficient water power by damming the South Saskatchewan river, to pump water from the river to the adjoining lands, and it was submitted that this scheme might be carried out in conjunction with the proposed South Saskatchewan water supply scheme.

No provision had been made in the yearly estimates for such a survey, but it was found possible to assign a seven-man party in charge of S. H. Hawkins to this work for a short time. Mr. Hawkins was instructed to investigate a number of sites along the rivers for power development, and to determine whether or not it might be feasible to extend the North Saskatchewan project southward across the South Saskatchewan river or the Red Deer river to the lands under consideration.

During the time the party was engaged on this work, about six weeks, a fairly complete reconnaissance was made of the South Saskatchewan and Red Deer river valleys from range 7, west of the 4th meridian, as far as Saskatchewan Landing in range 15, west of the 4th meridian.

One scheme which was thought might be possible was to cross the Red Deer river from the North Saskatchewan project at some point above its junction with the South Saskatchewan river, and irrigate any suitable lands between the Red Deer and South Saskatchewan rivers, such as the Tide Lake district, and then cross the South Saskatchewan river, and irrigate any suitable lands in the vicinity of Leader, Sceptre, Lancer and Cabri. Upon investigating this scheme several possible crossings were located on the South Saskatchewan river, but a very wide and deep depression to the east of this river precludes the possibility of reaching any such crossing from any point on the Red Deer river above range 3, west of the 4th meridian. This depression of which Willson lake, in township 20, range 4, west of the 4th meridian forms a part, heads at the South Saskatchewan river in township 20, range 5, west of the 4th meridian, and traverses the country in a northeasterly direction, coming out to the Red Deer river in township 22, range 3, west of the 4th meridian, and isolates all of that country between this depression and the South Saskatchewan river. Further than this it was found that there would be very little land suitable for irrigation, which could be commanded from any crossing of the Red Deer river above its confluence with the South Saskatchewan river. This scheme was therefore abandoned, and further efforts were made to either locate a crossing of the South Saskatchewan river below the mouth of the Red Deer river or some fit site, where power could be developed to pump water to the suitable lands known to exist in that vicinity.

Preliminary surveys were made of the following schemes:—

1. An extension of the canal system of the North Saskatchewan project across the South Saskatchewan river by means of a syphon in section 2, township 24, range 24, west of the 3rd meridian.
2. A pumping scheme from the South Saskatchewan river by means of power generated by a hydro-electric plant located on the river at some point in township 20, range 16, west of the 3rd meridian.

The first scheme has been considered in conjunction with the North Saskatchewan project, and the second in conjunction with a proposed hydro-electric power development, primarily for the purpose of supplying water to Moose Jaw, Regina and the surrounding districts. The first scheme provides for the irrigation of some 135,000 acres of land in the Leader, Prelate, Sceptre and Cabri districts, and the second scheme provides only for some 64,000 acres in the Cabri district.

The surveys made in connection with the first scheme consisted of making a cross-section of the river at the proposed crossing and running sufficient levels throughout the area thus commanded to determine approximately the location of supply canals and the extent of the irrigable area. In connection with this a possible reservoir site consisting of a depression in ranges 21 and 22, townships 22 and 23, was located from which lands bordering the south bank of the river in ranges 19, 20 and 21, could be irrigated.

In investigating the second scheme the economy gained by providing for a constant load on the pumps by the inclusion of a reservoir to take care of the peak requirements of the irrigable areas was kept in mind, as was also the necessity of so locating a pumping station that the pressure pipe-line would be as short as possible. With these objects in view a cross-section was made of a dam site at Pennant ferry for power development, a location on the south bank of the river in section 36, township 19, range 17, west of the 3rd meridian selected for a pumping station and a profile for the necessary pressure pipe-line run. A reconnaissance of Boggy lake at the northeast corner of township 18, range 14, west of the 3rd meridian for storage was made and sufficient levels run throughout the commanded area to determine the location of supply canals and the extent of the irrigable area.

From these very preliminary surveys some study has been made of the two schemes outlined, but since both depend upon other development, the first of the North Saskatchewan Irrigation project , and the second of a hydro-electric power development to pump water for Moose Jaw, Regina and the surrounding districts, it is not yet possible to arrive at any definite conclusion as to the feasibility of either.

By making full use of the Boggy Lake reservoir site the maximum capacity of which has been estimated at 98,000 acre-feet, it is possible to supply the requirements for 135,000 acres with a main canal of about 800 second-feet capacity. A syphon designed to carry this quantity across the river from the North Saskatchewan Irrigation project has been estimated at a cost of $750,000 to $1,000,000. This estimate is based on constructing a steel pipe 120 inches in diameter supported on cradles, and carried over the river by 13 steel spans each 125 feet in length, supported on piers. Accepting this latter amount the cost of this crossing would be at the rate of $7.40 per irrigable acre. The cost of the necessary distributary system has been estimated at approximately $20 per acre. To this must be added the cost of carrying the required amount of water from the rivers through the canals of the North Saskatchewan project.

By developing the Boggy Lake reservoir site to a capacity of forty to fifty thousand acre-feet to take care of the surplus water pumped, it is possible to provide for the requirements of 64,000 acres with a constant rate of flow from the pumps for seven months of 230 second-feet. The actual height to which this water would have to be lifted in order to gravitate to Boggy lake is 345 feet,

and the length of required pumping main 5,000 feet. Estimating on a 72-inch diameter pipe discharging at a velocity of approximately 8 feet per second, the friction head, through pumps and main, amounts to about 13 feet, making the total head on the pumps 358 feet, and the power required at the pumps about 12,000 B.H.P.

The following is an approximate estimate of cost exclusive of the cost to deliver power to the pumps:—

Pumps and main	$ 440,000
Boggy Lake reservoir (40,000 acre-feet)	265,000
Supply canal (main)	245,000
Division gates	11,000
Supply canals (secondary)	204,000
Distributing system	512,000
	1,677,000
Engineering and contingencies, 15%	251,550
	$ 1,928,550

That is, over and above the cost of power development, the estimated cost to irrigate 64,000 acres in the Cabri district would be over $30 per irrigable acre.

It has been suggested that cheap power might be supplied to this district from a plant constructed on the river primarily for the purpose of pumping a water supply to points in southern Saskatchewan. It is true that the construction of a dam of sufficient height to develop the necessary power to pump a water supply to Moose Jaw, Regina and the surrounding districts during the winter months, when the river is low, would create the necessary conditions for the development of immense surplus power when the river is high, but any power plant built to develop 11,000 horse-power would be very expensive, and it would seem that cheap power could not be made available in this way.

The possibility of power development is a question to be dealt with by the Dominion Water Power Branch and no estimate of cost has yet been attempted.

A profile of the proposed Pennant ferry dam site was made and a cost estimate based on a solid concrete overflow dam with an effective head of 30 feet at low stage which amounted to something like $2,000,000. Such a dam would be 2,000 feet in length at a maximum height of 50 feet.

The maximum recorded discharge of the South Saskatchewan river at Saskatoon is 114,000 second-feet and the minimum 1,124 second-feet. The theoretical power equivalent to the minimum flow under an effective head of 30 feet is less than 4,000 horse-power, which may not be sufficient to pump the water supply for southern Saskatchewan. The flow could be increased somewhat by raising the dam crest and creating storage. It is estimated that by raising the dam crest 10 feet about 170,000 acre-feet could be impounded with very little damage to property.

It is evident that power development on the South Saskatchewan river would be a very expensive undertaking, and further that the adjacent country offers very little market. The quantity required for the proposed South Saskatchewan water supply would only be a very small proportion of the supply required to pump for irrigation.

The higher lands which could be commanded by a crossing from the North Saskatchewan project are very suitable for irrigation, the soil being light, free from alkali, and the surface generally smooth. In that area under the proposed pumping scheme the lands are not so suitable, the soil for the most part consisting of a very heavy clay.

It was found that very little interest was taken in irrigation throughout this district, the opinions expressed indicating that the farmers are either indifferent or opposed to any extensive irrigation scheme. The feeling seems to be that with a return to normal precipitation, dry farming methods will be successful. This opinion was probably due to some extent to the fact that rains were frequent and heavy over this district during the time surveys were made and good crops were expected.

PROPOSED NORTH SASKATCHEWAN PROJECT

This project has been under consideration by the department for a number of years and has been discussed in previous branch reports.

During the past season preliminary surveys were continued, the following parties being employed: One 13-man location party; one 12-man location party; two 13-man levelling parties, and one 4-man reconnaissance party. These were employed during the whole of the field season, and an additional 8-man party for the purpose of making reservoir surveys was employed for about two months at the latter part of the season.

The levelling parties in charge of E. J. Switzer and R. V. Heathcott were employed to complete the township outline levels commenced the previous year, and to complete further topographical surveys of the irrigable tracts by running levels throughout townships in 2-mile squares. In addition to running these levels the parties also made a large number of soil tests and gained information regarding rainfall, crop yield, and other data pertaining to the irrigable areas. These parties were sent into the field May 10, one disbanding on November 14, and the other November 30. During this time they completed 934 miles of township outline levels, and 4,276 miles of section-line levels. They also established 73 standard bench-marks, procured and tested 288 soil samples and, from a field inspection, reported upon the topographical, soil conditions, and other features of 205 townships.

One location party in charge of M. H. Marshall was employed to make preliminary surveys for the main canals from the Red Deer river to Sullivan lake. This party was sent into the field about May 1, and disbanded on December 8. During this time the party ran 141·6 miles of traverse with profile and topography, made 6 river cross-sections, and 43 miles of reconnaissance. An area of 57,440 acres of the Sullivan lake basin was plane-tabled and 124 miles of township line levels run throughout the irrigable areas. The other location party in charge of I. R. Strome was employed to make the preliminary surveys of the main distributary from Sullivan lake, the supply canal to the proposed Tramping Lake reservoir and the main distributary from that reservoir. This party was sent into the field on May 10, and disbanded on November 28. During this time the party ran 471 miles of traverse with profile and topography, 260 miles of reconnaissance and check levels, established 6 standard bench-marks and made 145 ties to the land survey lines.

The reconaissance party in charge of A.B. Cook was employed first to make a reconaissance of a proposed diversion from Eyehill creek to Tramping lake (afterwards surveyed by Mr. Strome) and then a reconnaissance for an alternative route for the diversion of the Red Deer river. Upon the completion of this work the party was employed in making an exhaustive reconnaissance of the upper portion of the Red Deer River drainage basin with respect to storage. This party was sent into the field on May 9, and disbanded about the end of November. The accompanying map shows the location of the various reservoir sites investigated, and the accompanying table, shows the data compiled in connection with these sites.

For the purpose of making detailed surveys of some of the reservoir sites investigated by Mr. Cook, a special party was organized late in the season under J. C. Ells, and was employed to make surveys of reservoir sites on Stony creek, a branch of the James river. This party consisting of 8 men was sent into the field on September 13, and disbanded November 21. During this time detailed surveys were made of Burntstick lake in township 35, range 7, west of the 5th meridian, and the James River site in township 34, range 6, west of the 5th meridian. A reconnaissance was made of the Stony Creek reservoir site in townships 34 and 35, range 6, west of the 5th meridian, and possible diversions to this site from the James river and Teepeepole creek.

Irrigable Areas.—The lands comprising this project consist of all lands suitable for irrigation within a tract of 20,000,000 acres, its boundaries extending from a point near Coronation south of the Red Deer river near Duchess, and eastward as far as the South Saskatchewan river near Outlook and Saskatoon. Some investigations have been made to include lands to the south of the South Saskatchewan river adjoining the Empress branch of the Canadian Pacific railway, and also lands to the west of the Red Deer river along Kneehill, Threehills and Ghostpine creeks.

The following is an estimate of the irrigable areas in the various tracts as a result of the season's surveys.

Name of Tract	*Irrigable Area*
Sullivan Lake tract	73,190 acres
Berry Creek tract	304,930 "
Monitor tracts	49,240 "
Acadia Valley tract	58,460 "
Kindersley tracts	105,630 "
Elrose tracts	80,610 "
Rosetown tract	436,275 "
Saskatoon tract	302,645 "
Total	1,410,980 acres

In addition to the above it is estimated that approximately 135,000 acres to the south of the South Saskatchewan river can be irrigated by crossing the river in section 2, township 24, range 24, west of the 4th meridian, and there would be a considerable area of irrigable lands along Kneehill, Threehills, and Ghostpine creeks. As a result of last season's surveys an area of about 46,592 acres in the Kerrobert tracts previously included in the project has been cut out on account of expense, and other large areas in the tracts have been eliminated for the same reason.

Sullivan Lake Tract.—Land in this tract is generally rolling. Toward the western limit along Sounding creek in ranges 7 and 8 it becomes rough and only a small proportion is irrigable. Throughout portions of the area along Antelope lake and the head of Sounding creek the surface is very flat and dotted with small lakes and sloughs, showing indications of alkali. The best lands are along the western limit where the slope is steeper, but taking it as a whole it is not choice irrigable land. The soil is a sandy loam underlain with clay, and in some localities the surface soil is pure sand. This tract has at one time been fairly well settled, but considerable areas have now gone back to a virgin state owing to a large number of settlers having moved away. Farming conditions in this district have been very poor for a number of years owing to drought. The majority of the present settlers are in favour of irrigation.

Monitor Tracts.—Lands toward the east of these tracts in ranges 2 to 5 are rolling, and to some extent broken. The land, however, has a good slope toward Sounding creek and good general drainage. The soil here is sandy and well suited to irrigation. There are some surface indications of alkali throughout the lower lands. In range 6 the land is badly cut up by coulees running to the north branch of Sounding creek. The soil throughout is sandy loam underlain with clay. These tracts are only sparsely settled and there is apparently not much interest in irrigation.

Berry Creek Tract.—The general slope of this tract is towards Berry creek, which is the natural drainage. Lands north of township 26 are very rolling. The soil varies from a clay to a sandy loam underlain with clay. Throughout this area "burn-outs" occur frequently, and there are many surface indications of alkali. The best lands in this tract are contained in the area to the west of Berry creek between township 27 and the Red Deer river. This land has a good slope, the surface is smooth and contains a good proportion of irrigable land. The soil in general is a sandy loam underlain with light clay. Lands to the east of Berry creek in ranges 11 and 12 are fairly smooth with a good slope

to the south. The soil here is similar to that on the west side of the creek. In ranges 9 and 10 the lands are very badly cut up by coulees and are generally unsuitable for irrigation. A large proportion of this tract has been under cultivation for the past ten years, but owing to the lack of moisture, settlers are gradually moving out. A great many have already vacated their lands, and others will undoubtedly follow unless conditions are changed. The crops since 1916 have been practically a failure, ranging from 5 to 10 bushels of wheat to the acre. The majority of the settlers are in favour of irrigation.

Acadia Valley Tract.—The general slope of this tract is toward Kennedy coulee which is the natural drainage. The best lands are within two or three miles on either side of the creek. Farther from the coulee the lands become more rolling and in township 23, ranges 2 and 3 bordering on the Red Deer river they are so cut up by coulees as to be practically non-irrigable. The soil is a light clay loam underlain with clay. Very little alkali appears on the surface but is found to some extent at depths from 4 to 5 feet.

This tract is well settled and farming is carried on quite extensively. The rainfall during the past six years has been light, but owing to the nature of the soil and the better class of farmer who has settled in this district, fairly good crops have been produced; the yield for wheat in 1922 ranging from 10 to 25 bushels to the acre. Irrigation is looked upon favourably throughout this district.

Kindersley Tracts.—The topography throughout these tracts varies greatly. In townships 24 and 25, ranges 23, 24, 25 and 26 the lands are very rolling, although odd sections are found where the land is very suitable for irrigation. Throughout townships 26, 27, 28 and 29, ranges 23 and 24, the lands are smooth with an even slope toward a large depression which drains to a lake bottom in township 26, range 23. A very large proportion of the lands in township 26, ranges 23 and 24, is irrigable. The soil throughout these tracts varies from a light clay loam to a heavy clay loam underlain with heavy clay. There is very little surface alkali throughout the tracts, but soil tests show weak alkali at depths from 3 to 5 feet. The larger part of these tracts is well settled with fairly prosperous farmers. The crop yields have been good compared with other districts in the project. During 1922 the yield for wheat ranged from 10 to 30 bushels per acre. About 50 per cent of the farmers are not in favour of irrigation, claiming that there is sufficient rainfall. The other 50 per cent are in favour of irrigation if the cost is reasonable.

Elrose Tracts.—A comparatively small area of land in township 26, range 18, is irrigable having a smooth even slope. The soil here is a light clay loam underlain with heavy clay. Soil tests show weak alkali at depths from 3 to 5 feet. Lands in townships 26 and 27, range 16, are rolling with a general slope towards the east. The proportion of irrigable land is not very great. The soil is a light clay loam underlain with clay, and is apparently free from alkali. The Elrose tracts are fairly well settled, and fair crops were produced in 1922.

Rosetown Tract.—This tract includes the largest concentrated area of irrigable land in the project. The topographical and soil conditions vary greatly, but generally the lands are from smooth to gently rolling, and the soil generally a light clay loam. Throughout the southern portion in the vicinity of Elrose and Rosetown, from townships 25 to 30, ranges 11 to 15, the conditions for irrigation are excellent. The surface is smooth but with sufficient slope, and the soil is a light clay loam. Good drainage is provided by numerous creeks and water-courses running to the northeast, and except in places along the creeks there is very little indication of alkali. To the north of township 30 the lands are generally a little more rolling, becoming distinctly rolling toward the western limit where the Bear hills commence. This area is drained by Eagle Hill creek and its various branches. To the west of Eagle Hill creek there is good slope,

but to the east some of the lands are flatter and may require drainage. There are quite a number of sand ridges, which makes classification difficult, the most notable of which is in the vicinity of the town of Harris on the Canadian National railway between Rosetown and Saskatoon. This ridge is very rough and consists of almost pure sand. It is covered with foliage of various kinds, and a lake situated in these hills has become quite a summer resort. To the extreme north the soil is heavier and the surface more rolling, becoming distinctly rolling toward the northwest limit.

Saskatoon Tract.—This tract is badly cut up by sand ridges and large areas are thus rendered non-irrigable. The soil varies from a light clay loam to a sandy loam, becoming distinctly sandy approaching the Saskatchewan river.

ENGINEERING FEATURES

North Saskatchewan River Diversion.—It is proposed to divert the North Saskatchewan river at a point in section 26, township 29, range 9, west of the 4th meridian by means of a gravity type concrete weir 1,880 feet in length with a maximum height of 50 feet. The length of canal between the North Saskatchewan and Clearwater rivers will be 28 miles, and has been designed for a capacity of 6,800 second-feet. For a distance of about 1,200 feet immediately below the intake it is in cut with a maximum depth of 12 feet above full supply level. Several miles of the canal just above the crossing of Cow creek will be on very steep side-hill. For the remainder of the distance no unusual difficulties are anticipated. Three large flumes will be required to carry the canal across coulees.

Clearwater River Diversion.—At the point where it is proposed to divert the Clearwater river there is a low divide between the river and the head of Stauffer creek. It is proposed to divert the Clearwater in section 26, township 37, range 6, west of the 5th meridian by means of a concrete weir, 1,100 feet in length with a maximum height of 6 feet and carry the water over this summit into the head of Stauffer creek, and thus by the Raven river to the Red Deer river. The only expensive feature about this diversion is the protection work necessary to prevent the river in flood from backing over this low summit and destroying the headworks and canal. Provision has been made in the estimates for extensive earth fills. After dropping the water into the head of Stauffer creek, it will flow freely down to the Red Deer river, and provision has been made in the estimates to expropriate extensive right of way along these creeks.

Red Deer Diversion.—It is proposed to divert the Red Deer river in section 4, township 38, range 25, west of the 4th meridian by means of an earth dam 4,500 feet in length with a maximum height of 174 feet. It is estimated that the cost of such a dam will be approximately $4,787,200. On account of the immense cost of this structure an alternative point of diversion just below the mouth of the Raven river has been investigated. It would be possible to divert the river here by means of a dam 50 feet high. No surveys have yet been made of this scheme, and the attached estimates are based on diversion by means of the high and expensive dam above mentioned. The canal from the Red Deer river to Sullivan Lake reservoir has been designed to carry 9,946 second-feet, and will be 98 miles in length. With the exception of several miles just below the intake this canal will be in good country for canal construction. The Red Deer river is crossed in section 10, township 38, range 22, west of the 4th meridian, by means of an inverted syphon consisting of 5 steel pipes 4,360 feet in length under a maximum head of 300 feet.

Sullivan Lake Reservoir Site.—This is an excellent site in which to store large quantities of water. A plane-table survey has been made of this site, and it is estimated that it can be developed to a capacity of 1,951,131 acre-

feet if necessary. Cost estimates have been made for the development up to 1,730,000 acre-feet at a total cost of $1,853,183.

Sounding Creek Natural Channel.—It is proposed to carry the amount of water required for the Rosetown and Saskatoon tracts for a considerable distance (about 200 miles) through the natural channels of Sounding and Eyehill creeks. Provision has been made in the estimates to expropriate extensive right of way along these channels. No provision has been made for structures to control the flow of water along these creeks, although it is possible after some years of operation that certain structures will be required.

Eyehill Creek Diversion Canal.—It is proposed to divert the water from Eyehill creek in section 11, township 41, range 27, west of the 3rd meridian by means of an earth dam 1,700 feet in length with a maximum height of 40 feet. Provision has also been made to spill 5,500 second-feet at this point back into Eyehill creek. The canal from Eyehill creek to Tramping lake will be approximately 55 miles in length and has been designed for a capacity of 5,129 second-feet. A portion of this canal will be through sand hills where excavation quantities will be high, and 3 large structures are required to carry the canal across depressions at a cost of $2,458,000. This section of the canal has been designed to carry approximately 4,800 second-feet.

Tramping Lake Reservoir Site.—No surveys have yet been made of this site, but, from a reconnaissance, an approximate estimate of the storage capacity has been made and cost estimates compiled. It is estimated that this site can be developed to a capacity of 320,000 acre-feet at a cost of $718,818, but detailed surveys will be necessary before any close estimates can be made.

Main Distributaries from Tramping Lake.—It is proposed to divert the water required for the Rosetown and Saskatoon tracts from Eagle Hill creek in section 18, township 34, range 19, west of the 3rd meridian and carry it along the valley of Eagle Hill creek to a point in the SW. $\frac{1}{4}$ of section 13, township 31, range 16, west of the 3rd meridian, where it is divided. One canal runs north along the base of the White Bear hills, and supplies the lands to the east of Eagle Hill creek. There are no outstanding features about this canal. For the most part it is in easy country, and the excavation quantities will not be out of the ordinary. The other canal is carried to the south across Eagle Hill creek and supplies water to about 600,000 acres. The inverted syphon required to carry the water across this creek is the most expensive structure in the project. The cost estimate is based on constructing four $16\frac{1}{2}$-foot diameter steel pipes each 12,600 feet in length under a maximum head of 100 feet. The estimated cost of this structure is $6,419,480. A number of other fairly large structures are required, but no construction difficulties are anticipated.

Main Canal to the Acadia Valley, Kindersley and Elrose Tracts.—The total length of the canal from Sullivan lake to Elrose is 393 miles. Considerable stretches of this canal will be in rough country and excavation quantities high. A number of expensive structures are required, the most notable being the syphon required to carry the canal across a depression near the head of Cabri lake in township 6, ranges 27 and 28, west of the 3rd meridian. The structure required here consists of one 17-foot diameter steel pipe, 21,200 feet in length, under a maximum head of 120 feet. The estimated cost of this structure is $2,757,850. Owing to the long stretches of non-productive territory through which this canal will have to be built, absorption losses per acre will be high and the cost per acre excessive.

Main Canals to Berry Creek Tract.—The water is carried to this tract by two large canals one on either side of Berry creek. These will be contour canals and throughout portions of their lengths the excavation quantities will be high. No large structures are required.

Water Supply and Canal Design.—A study of the available water supply, main canal design, and storage capacity required has been made, and tables have been prepared showing how the project could have been economically operated from 1914 to 1921 inclusive.

The absorption losses are unusually high, amounting to 53·6 per cent of the gross supply. This estimate of losses is based on 6 second-feet per million square feet of wetted area, except in natural channels of Stauffer creek, Raven river, and Sounding and Eyehill creeks, where losses of one-half this amount have been assumed. The losses in Tramping and Sullivan lakes, over and above the run-off to those lakes, have been taken as equivalent to a depth of 3 feet over the total full supply areas. No losses have been allowed for, in transporting water through the channel of the Red Deer river between the mouth of the Raven river and intake in section 4, township 38, range 25. It is estimated that the run-off particularly from the Blindman river will more than balance the absorption losses. An allowance has been made for riparian rights in Red Deer river of 100 second-feet, and in Clearwater river of 50 second-feet.

In estimating the requirements a net duty of 18 inches on 80 per cent of the irrigable area has been assumed and the methods of monthly distribution are as follows:—May, 2 inches; June, 6 inches; July, 6 inches; August, 2 inches; September, 2 inches.

It is considered impractical to operate canals from the rivers before the beginning of May and after the end of October, and in preparing the tables an open-water season of six months has been used. Allowing for absorption losses at 53·6 per cent of the gross supply the requirement for 1,410,980 acres is 3,648,157 acre-feet, which is equivalent to a continuous flow during the open-water season of 10,015 second-feet. For the purpose of regulating this flow to provide for peak load requirements the following storage is required:—

Sullivan Lake reservoir	1,000,000	acre-feet
Tramping Lake reservoir	320,000	"

In order to maintain a continuous flow from the rivers of 10,015 second-feet immense storage reservoirs are required on the rivers, and in preparing the tables the following storage has been considered:—

North Saskatchewan river	366,477	acre-feet
Clearwater river	214,500	"
Red Deer river	387,485	"
Total	968,462	"

With this storage it is possible to divert the following quantities continuously:—

Red Deer river	2,275	second-feet
Clearwater river	1,180	"
North Saskatchewan river	6,380	"
Total	9,835	"

This is short of the requirement by 180 second-feet, so that it is necessary to provide for this by increasing the canal capacity from the North Saskatchewan river to 6,800 second-feet, in order to provide for this from the flood water over and above what is stored in the reservoir. This flood water is carried to Sullivan lake where it is carried over from year to year. Table No. 1 shows the operation of canals and reservoirs to irrigate 1,410,980 acres.

In the following tracts directly under Sullivan lake, there is a total area of 427,360 acres of land made up as follows:—

Monitor tracts	49,240	acres
Sullivan Lake tract	73,190	"
Berry Creek tract	304,930	"

Table No. 2 shows the operation of a scheme to irrigate this area.

Table No. 3 has been prepared to show the total area which could be irrigated from the Red Deer and Clearwater rivers without storage on these streams. By developing the Sullivan Lake site to a capacity of 1,210,000 acre-feet and constructing a supply canal from the Red Deer river, it would be possible to irrigate 570,000 acres.

In the event of diverting the Red Deer river at a point just below the mouth of the Raven river there would be considerable areas irrigable along the valleys of Kneehill, Threehills and Ghostpine creeks, which in addition to the 427,360 acres above referred to, would probably bring the total up to something like 570,000 acres.

Before any reliable cost estimate could be made for such a scheme, it would be necessary to make surveys for a canal from the mouth of the Raven river to the Red Deer river crossing in section 10, township 38, range 22, west of the 4th meridian and of the irrigable areas under this canal.

Preparation of Cost Estimates.—No attempt has been made to obtain any close cost estimates, but those following are an approximation of the total cost of the project. The whole lateral distributary and main canal system have been projected upon topographic maps, scale 1 inch to 5,000 feet, and approximate estimates made from these. The whole of the irrigable area has been divided into a number of tracts as shown on the accompanying map and these tracts subdivided into zones of from 10,000 to 40,000 acres each. By comparison with the estimated cost of a number of other projects of approximately the same areas as these zones, unit costs per acre have been derived, and the lateral system estimated on this basis. The larger distributary canals have all been designed and approximate estimates including excavation, right of way, fencing, telephone system, bridges and other structures prepared. Main canals have all been designed and projected, and complete estimates prepared. Designs have been prepared for the larger structures, and cost estimates based on these. Approximate cost estimates for smaller structures have been made from comparison with similar structures estimated for other projects.

Discussion of Estimates.—It has been pointed out that no attempt has been made to prepare detailed estimates. In the first place there are as yet insufficient field data available from which to prepare them, and in the second place it has not been possible to assign a sufficiently large staff to this work to make the necessary detailed studies of the project. The idea in preparing the approximate estimates submitted was to determine whether or not the project is a feasible one, and it is believed that the estimates submitted are sufficiently close for that purpose.

From the following estimates it will be seen, that it is not feasible at present to irrigate the whole 1,410,980 acres, the estimated cost being $74.84 per irrigable acre. The estimated cost to irrigate 427,360 acres is $55.00 per acre, which is also high.

By revising the main canal from the Red Deer river to take out at the mouth of the Raven river and including those irrigable lands along Kneehill, Threehills, and Ghostpine creeks, it is probable that a feasible scheme could be developed. A rough estimate of such a scheme is as follows:—

Laterals and distributaries for 427,360 acres under Sullivan lake	$ 9,039,151
Laterals and distributaries for 142,640 acres under Ghostpine, Kneehill and Threehills creeks	2,852,800
Canal from Sullivan lake to Red Deer river at mouth of Raven river, 164 miles at $65,000 per mile	10,660,000
Syphon on Red Deer river	1,100,000
Weir and headgates Red Deer river	1,000,000
Drops	500,000
Total	$ 25,151,951
Contingencies 10%	2,515,195
Total	$ 27,667,146

Cost per acre, $48.50.

All plans in connection with this project have been filed in the office of the Commissioner of Irrigation at Calgary.

UNIT COSTS

The following unit costs have been used in the preparation of cost estimates:–

Excavation	$ 0.24 per cu. yd.
Timber in place—	
Large flumes, etc., including haul	$ 70.00 per M.
Small structures, including haul	$100.00 "
Concrete—	
Reinforced, average	27.50 per cu. yd.
Plain, average	19.50 "
Riprap, loose	2.00 "
Riprap, bonded	3.50 "
Wood pipes—	
Based on curves prepared from prices submitted by the Pacific Coast Pipe Company.	
Steel pipes in place	0.11 per lb.
Embankment earth dams	0.25 to $0.45 per cu. yd.
Rock-fill dams—	
Quarry run	1.00 per cu. yd.
Derrick laid	1.50 "
Dry masonry	4.50 "
Right of way—	
Excavated canals	$ 15.00 to $45.00 per acre.
Natural channels—	
Excavation in foundations	0.50 per cu. yd.
Excavation wet	1.50 "
Excavation solid rock foundation	4.00 "
Telephone system	275.00 per mile
Fencing	350.00 "

PROPOSED NORTH SASKATCHEWAN PROJECT—RESERVOIR DETAILS

Name	Dam Location	Superficial Area Acres	Capacity Acre-feet	Total Cost	Cost per Acre-foot	Data Available
Douglas lake	7–30–14–5	1,458	64,500	$ 756,513	$ 11.73	Reconnaissance only.
Red Deer river No. 1	16–31–14–5	545	21,000	493,264	23.44	" "
Red Deer river No. 2	6–32–12–5	2,192	142,500	1,977,841	13.88	" "
Red Deer river No. 3	34–31–11–5	....	....	....	....	Abandoned after reconnaissance.
Red Deer river No. 4	18–31–10–5	1,490	67,000	805,430	12.02	Reconnaissance only.
Burntstick lake	7–35–6–5	1,804	40,360	158,584	3.93	Detail survey.
Stony Creek reservoir	29–34–6–5	2,230	52,125	326,775	6.27*	Reconnaissance only.
The "Gap" Clearwater river	35–10–5	3,130	214,500	1,867,462	8.71	Reconnaissance by Dom. Pub. Wks. Dept.
The "Gap," North Saskatchewan river	39–14–5	4,290	309,000	2,109,925	6·83	" "
Glacier lake	34–20–	5.........	54,477	139,927	2.57	" "
James River site	7–34–6–5	1,226	48,652	1,118,902	23.00	Detail survey.
Panther River site	28–30–12–5	....	....	....	....	Abandoned after reconnaissance.
Sullivan Lake site	18–35–13–4	....	1,730,000	1,853,183	1.07	Detail survey.
Tramping Lake site	NE¼ 23–24–20–3	....	320,000	718,818	2.25	Reconnaissance only.

*Includes cost of diversion canal from the James river.

NORTH SASKATCHEWAN PROJECT—CONDENSED ESTIMATE OF COST

	Estimated cost plus 10 per cent
River storage—	
North Saskatchewan river 363,477 acre-feet	$ 2,249,852
Clearwater river, 214,500 acre-feet	1,867,462
Red Deer river, 387,485 acre-feet	4,518,407
	$ 8,635,721
North Saskatchewan river diversion—	
Diversion dam and headgates N. Sask. river	$ 1,077,890
Canal complete North Sask. to Clearwater river	3,375,595
	$ 4,453,485
Clearwater river diversion—	
Diversion weir and headgates Clearwater river	$ 227,865
Canal and natural channel Stauffer cr. and Raven river	620,497
	$ 848,362
Red Deer river diversion—	
Diversion dam and headgates Red Deer river	$ 4,787,200
Canal complete Red Deer river to Sullivan lake	13,387,917
	$ 18,175,117
Development of Sullivan lake storage—	
Dams and headgates	$ 473,523
Land damages	1,379,660
	$ 1,853,183

Tramping lake feeder canal—		
Natural channel Sounding and Eyehill creeks	$	1,059,549
Dam, headgate and spillway Eyehill creek		176,891
Canal complete Eyehill cr. to Tramping lake		7,635,411
	$	8,871,851
Development of Tramping lake storage—		
Dam and headgates	$	362,453
Other structures		261,550
Land damages		94,815
	$	718,818
Main canal from Tramping lake to Anglia syphon—		
Dam gates and spillway	$	105,297
Canal complete Tramping lake to Anglia syphon		7,659,600
	$	7,764,897
Tramping lake system, 738,920 acres—		
Lateral system	$	5,029,795
Distributary canals		19,641,239
	$	24,671,034
Sullivan lake system, 672,060 acres—		
Lateral system	$	7,316,617
Distributary system		22,291,075
	$	29,607,692
Total cost	$ 105,600,160	
Cost per acre	$74.84	

Cost estimate for main and distributary canals and lateral system for 427,360 acres under Sullivan lake including the following tracts:—

Monitor tracts		49,240 acres.
Sullivan lake tract		73,190 "
Berry creek tract		304,930 "
Lateral and distributary systems complete $6.30 to $17 per acre	$	3,991,416
Main canals excavation, 15,855,293 cu. yds. at 24c		3,805,270
" right of way, 397·8 acres at $25 per acre		99,395
" telephone system, 298·4 miles at $275 per mile		79,585
" fencing 289·4 miles at $350 per mile		101,290
" steel and timber bridges		658,733
" drops		173,531
" division gates		59,905
Kirkpatrick lake storage fill and riprap		70,026
Total	$	9,039,151
Engineering 10 per cent		903,915
Total	$	9,943,066

Cost per acre—$23.26.

Summary of cost of scheme to irrigate 427,360 acres:—

Clearwater river diversion—			
Diversion works	$	209,110	
Canal and natural channel		350,119	
		$	559,229
Red Deer diversion—			
Diversion dam and headgates Red Deer river	$	4,759,700	
Canal complete, Red Deer river to Sullivan lake		6,806,921	
		$	11,566,621
Development of Sullivan lake storage—			
Dams and headgate	$	385,000	
Land damages		1,056,000	$ 1,441,000
Canal System, 427,360 acres—			
Laterals	$	4,390,558	
Distributary canals		5,552,508	
		$	9,943,066
Total cost		$	23,509,916

Cost per acre—$55.

NORTH SASKATCHEWAN IRRIGATION PROJECT—WATER SUPPLY TABLE No. 1

River	River Storage	Canal Capacity
Red Deer	387,485 acre-feet	2,275 c.f.s.
Clearwater	214,500 "	1,180 "
North Saskatchewan	363,477 "	6,800 "
Totals	965,462 "	10,255 "

Total irrigable area.......1,410,980 acres Net duty of water........1·5 feet per acre
Irrigation factor..........80% Total losses..............53·6% of gross water supply

Irrigation May, Aug., Sept., 2 inches. June and July 6 inches.
Regulating reservoirs at Sullivan Lake and Tramping Lake.
Losses in regulating reservoirs, 3 feet per year.

NORTH SASKATCHEWAN IRRIGATION PROJECT

SHOWING AVAILABLE WATER SUPPLY FROM RED DEER, CLEARWATER AND NORTH SASKATCHEWAN RIVERS. REQUIREMENTS ON THE LAND AND OPERATION OF THE REGULATING RESERVOIRS.

Net Duty of Water, 18" per Acre. Total Area, 1,410,980 Acres

Period	Water Diverted from Rivers in Acre-feet					Requirements in Acre-feet—Gross at Sullivan Lake				Gross at Tramping Lake in Acre-feet		
	Drawn from Red Deer	Drawn from Clearwater	Drawn from North Sask.	Total: Gross at Intakes	80·4 p.c. Total: Gross Available Outlet Sullivan Lake	Area under Sullivan Lake	Area under Tramping Lake	Total	Operation of Sullivan Lake	Run to Tramping Lake	Area under Tramping Lake	Operation of Tramping Lake + Losses
1914									Estimated 500,000			Est. Cap. + Losses 352,000
May	139,640	72,428	417,384	629,452	506,079	142,010	179,357	321,367	684,712	146,176	146,176	352,000
June	135,135	70,092	403,920	609,147	489,754	426,028	336,501	762,529	411,937	274,131	438,528	187,603
July	139,640	72,428	417,384	629,452	506,079	426,028	347,718	773,746	144,276	283,269	438,528	32,344
August	139,640	72,428	417,384	629,452	506,079	142,010	347,718	489,728	160,621	283,269	146,176	137,093
September	135,135	70,092	403,920	609,147	489,754	142,010	336,501	478,511	171,864	274,131	146,176	265,048
October	139,640	72,428	365,398	577,466	464,283	....	105,690	106,690	529,457	86,952	....	352,000
Total	828,830	429,896	2,425,390	3,684,116	2,962,028	1,278,086	1,654,485	2,932,571	....	1,347,948	1,315,584	....
1915												
May	139,640	72,428	417,384	629,452	506,079	142,010	179,357	321,367	714,169	146,176	146,176	352,000
June	135,135	70,092	403,920	609,147	489,754	426,028	336,501	762,529	441,394	274,131	438,528	187,603
July	139,640	72,428	417,384	629,452	506,079	426,028	347,718	773,746	173,727	283,269	438,528	32,344
August	139,640	72,428	417,384	629,452	506,079	142,010	347,718	489,728	190,078	283,269	146,176	137,093
September	135,135	70,092	403,920	609,147	489,754	142,010	336,501	478,511	201,321	274,131	146,176	265,048
October	139,640	72,428	411,007	623,075	500,952	....	106,690	106,690	595,583	86,952	....	352,000
Total	828,830	429,896	2,470,999	3,729,725	2,998,697	1,278,086	1,654,485	2,932,571	....	1,347,948	1,315,584	....

1916												
May	72,428	139,640	417,384	629,452	506,079	142,010	179,357	321,367	780,295	146,176	146,176	352,000
June	70,092	135,135	403,920	609,147	489,754	426,028	336,501	762,529	507,520	274,131	438,528	187,603
July	72,428	139,640	417,384	629,452	506,079	426,028	347,718	773,746	239,853	283,269	438,528	32,344
August	72,428	139,640	417,384	629,452	506,079	142,010	347,718	489,728	256,204	283,269	146,176	137,093
September	70,092	135,135	403,920	609,147	489,754	142,010	336,501	478,511	267,447	274,131	146,776	265,048
October	72,428	139,640	417,384	629,452	506,079	....	106,690	106,690	666,836	86,952	....	352,000
Total	429,896	828,830	2,477,376	3,736,102	3,003,824	1,278,086	1,654,485	2,932,571	....	1,347,948	1,315,584	....
1917												
May	72,428	139,640	417,384	629,452	506,079	142,010	179,357	321,367	851,548	146,176	146,176	352,000
June	70,092	135,135	403,920	609,147	489,754	426,028	336,501	762,529	578,773	274,131	438,528	187,603
July	72,428	139,640	417,384	629,452	506,079	426,028	347,718	773,746	311,106	283,269	438,528	32,344
August	72,428	139,640	417,384	629,452	506,079	142,010	347,718	489,728	327,457	283,269	146,176	137,093
September	70,092	135,135	403,920	609,147	489,754	142,010	336,501	478,511	338,700	274,131	146,176	265,048
October	72,428	139,640	417,384	629,452	506,079	....	106,690	106,690	738,089	86,952	....	352,000
Total	429,896	828,830	2,477,376	3,736,102	3,003,824	1,278,086	1,654,485	2,932,571	....	1,347,948	1,315,584	....
1918												
May	72,428	139,640	417,384	629,452	506,079	142,010	179,357	321,367	922,801	146,176	146,176	352,000
June	70,092	135,135	403,863	609,090	489,708	426,028	336,501	762,529	649,980	274,131	438,528	187,603
July	72,428	139,640	[illegible]	[illegible]	506,079	426,028	347,718	773,746	382,313	283,269	438,528	32,344
August	72,428	139,640	417,384	629,452	506,079	142,010	347,718	489,728	398,664	283,269	146,176	137,093
September	70,092	135,135	403,920	609,147	489,754	142,010	336,501	478,511	409,907	274,131	146,176	265,048
October	72,428	139,640	417,384	629,452	506,079	....	106,690	106,690	809,296	86,952	....	352,000
Total	429,896	828,830	2,417,319	3,736,045	3,003,778	1,278,086	1,654,485	2,932,571	....	1,347,948	1,315,584	....
1919												
May	72,428	139,640	417,384	629,452	506,079	142,010	179,357	321,367	994,008	146,176	146,176	352,000
June	70,092	135,135	313,822	519,049	417,315	426,028	336,501	762,529	648,794	274,131	438,528	187,603
July	72,428	139,640	417,384	629,452	506,079	426,028	347,718	773,746	381,127	283,269	438,528	32,344
August	72,428	139,640	417,384	629,452	506,079	142,010	347,718	489,728	397,478	283,269	146,176	137,093
September	70,092	135,135	403,920	609,147	489,754	142,010	336,501	478,511	408,721	274,131	146,176	265,048
October	72,428	139,640	398,089	610,157	490,566	....	106,690	106,690	792,597	86,952	....	352,000
Total	429,896	828,830	2,367,983	3,626,709	2,915,872	1,278,086	1,654,485	2,932,571	....	1,347,948	1,315,584	....
1920												
May	72,428	139,640	417,384	629,452	506,079	142,010	179,357	321,367	977,309	146,176	146,176	352,000
June	70,092	135,135	403,920	609,147	489,754	426,028	336,501	762,529	704,534	274,131	438,528	187,603
July	72,428	139,640	417,384	629,452	506,079	426,028	347,718	773,746	436,867	283,269	438,528	32,344
August	72,428	139,640	417,384	629,452	506,079	142,010	347,718	489,728	453,218	283,269	146,176	137,093
September	70,092	135,135	403,920	609,147	489,754	142,010	336,501	478,511	464,461	274,131	146,176	265,048
October	72,428	139,640	342,491	554,559	445,865	....	106,690	106,690	803,636	86,952	....	352,000
Total	429,896	828,830	2,402,483	3,661,209	2,943,610	1,278,086	1,654,485	2,932,571	....	1,347,948	1,315,584	....
1921												
May	72,428	139,640	417,384	629,452	506,079	143,010	179,357	321,367	988,348	146,176	146,176	352,000
June	70,092	135,135	403,920	609,147	489,754	426,028	336,501	762,529	715,573	274,131	438,528	187,603
July	72,428	139,640	417,384	629,452	506,079	426,028	347,718	773,746	447,906	283,269	438,528	32,344
August	72,428	139,640	417,384	629,452	506,079	142,010	347,718	489,728	464,257	283,269	146,176	137,093
September	70,092	135,135	403,920	609,147	489,754	142,010	336,501	478,511	475,500	274,131	146,176	265,048
October	72,428	139,640	177,828	389,896	313,476	....	106,690	106,690	682,286	86,952	....	352,000
Total	429,896	828,830	2,237,820	3,496,546	2,811,221	1,278,086	1,654,485	2,932,571	....	1,347,948	1,315,584	....

NORTH SASKATCHEWAN IRRIGATION PROJECT

WATER SUPPLY TABLE No. 2

Using Red Deer and Clearwater rivers only, without river storage. Possible to irrigate a total area of 427,360 acres

Maximum capacity from Red Deer River, 2,300 c.f.s.
Maximum capacity from Clearwater River, 1,000 c.f.s.
} Total max. capacity, 3,300 c.f.s.

Irrigation factor........................80%
Net duty of water........................1·5 feet.
Total losses............................45% of gross supply.

Irrigations, May, Aug., Sept., 2 inches, June and July 6 inches.
Regulating reservoir at Sullivan lake.

NORTH SASKATCHEWAN IRRIGATION PROJECT

TABLE—Showing available water supply from Red Deer and Clearwater rivers without river storage, sufficient to irrigate 427,360 acres.

Net Duty of water 18″ per Acre. Irrigable Area, 427,360 Acres
Table No. 2.

Period	Water Diverted from Rivers in Acre-feet: Drawn from Red Deer	Drawn from Clear-water	Total: Gross at Intakes	80 per cent of Total: Gross Available Sullivan Lake	Gross Required Sullivan Lake	Operation of Sullivan Lake: To Storage	From Storage	Balance in Sullivan Lake
					Acre-feet	Acre-feet	Acre-feet Est.	Acre-feet 200,000
1914								
May..............	110,783	41,453	152,236	121,689	79,806	41,983	....	241,983
June..............	132,937	54,785	187,722	150,178	239,417	....	89,239	152,744
July..............	121,899	59,406	181,305	145,044	239,417	....	94,373	58,371
August............	74,350	45,076	119,426	95,541	79,806	15,735	....	74,106
September.........	59,395	33,328	92,723	74,178	79,806	....	5,628	68,478
October...........	81,747	34,008	115,755	92,604	....	92,604	....	161,082
Total..........	581,111	268,056	849,167	679,334	718,252	150,322	189,240	....
1915								
May..............	137,056	57,735	194,791	155,833	79,806	76,027	....	237,109
June..............	136,620	59,400	196,020	156,816	239,417	....	82,601	154,508
July..............	141,174	61,380	202,554	162,043	239,417	....	77,374	77,134
August............	141,174	61,380	202,554	162,043	79,806	82,237	....	159,371
September.........	136,620	59,400	196,020	156,816	79,806	77,010	....	236,381
October...........	139,985	56,163	196,149	156,919	....	156,919	....	393,300
Total..........	832,630	355,458	1,188,088	950,470	718,252	392,193	159,975	....
1916								
May..............	132,809	49,965	182,774	146,219	79,806	66,413	....	459,713
June..............	136,620	59,400	196,020	156,816	239,417	....	82,601	377,112
July..............	141,174	61,380	202,554	162,043	239,417	....	77,374	299,738
August............	141,174	61,380	202,554	162,043	79,806	82,237	....	381,975
September.........	136,620	59,400	196,020	156,816	79,806	77,010	....	458,985
October...........	141,174	61,240	202,414	161,931	....	161,931	....	620,916
Total..........	829,571	352,765	1,182,336	945,868	718,252	387,591	159,975	....
1917								
May..............	141,174	58,115	199,289	159,431	79,806	79,625	....	700,541
June..............	136,620	59,400	196,020	156,816	239,417	....	82,601	617,940
July..............	140,382	61,380	201,762	161,410	239,417	....	78,007	539,933
August............	120,991	58,687	179,678	143,742	79,806	63,936	....	603,869
September.........	106,815	54,311	161,126	128,901	79,806	49,095	....	652,964
October...........	86,826	42,186	129,012	103,210	....	103,210	....	756,174
Total..........	732,808	334,079	1,066,887	853,510	718,252	295,866	160,608	....
1918								
May..............	110,566	43,900	154,466	123,573	79,806	43,767	....	799,941
June..............	135,432	57,420	192,852	154,282	239,417	....	85,135	714,806
July..............	107,850	54,016	161,866	129,493	239,417	....	109,924	604,882
August............	102,101	54,393	156,494	125,195	79,806	45,389	....	650,271
September.........	73,408	39,278	112,686	90,149	79,806	10,343	....	660,614
October...........	53,751	29,458	83,209	66,567	....	66,567	....	727,181
Total..........	583,108	278,465	861,573	689,259	718,252	166,066	195,059	....

NORTH SASKATCHEWAN IRRIGATION PROJECT—WATER SUPPLY TABLE No. 2—Continued.

Period	Water Diverted from Rivers in Acre-feet				Gross Required Sullivan Lake	Operation of Sullivan Lake		
	Drawn from Red Deer	Drawn from Clear-water	Total: Gross at Intakes	80 per cent of Total: Gross Available Sullivan Lake		To Storage	From Storage	Balance in Sullivan Lake
1919					Acre-feet	Acre-feet	Acre-feet	Acre-feet
May	113,400	43,303	156,703	125,362	79,806	45,556	....	772,737
June	102,378	40,548	142,926	114,341	239,417	....	125,076	647,661
July	78,531	43,170	121,701	97,361	239,417	....	142,056	505,605
August	105,720	57,192	162,912	130,330	79,806	50,524	....	556,129
September	62,787	44,514	107,301	85,841	79,806	6,035	....	562,164
October	34,567	27,429	61,996	49,597	....	49,597	....	611,761
Total	497,383	256,156	753,539	602,832	718,252	151,712	267,132	....
1920								
May	141,174	56,291	197,465	157,972	79,806	78,166	....	689,927
June	136,620	59,400	196,020	156,816	239,417	....	82,601	607,326
July	141,174	61,380	202,554	162,043	239,417	....	77,374	529,952
August	95,440	56,644	152,084	121,667	79,806	41,861	....	571,813
September	42,734	33,927	76,661	61,329	79,806	....	18,477	553,336
October	28,348	22,221	50,569	40,455	....	40,455	....	593,791
Total	585,490	289,863	875,353	700,282	718,252	160,482	178,452	....
1921								
May	130,475	57,519	187,994	150,395	79,806	70,589	....	664,380
June	129,820	58,707	188,527	150,822	239,417	....	88,595	575,785
July	103,847	55,191	159,038	127,230	239,417	....	112,187	463,598
August	74,300	47,676	121,976	97,581	79,806	17,775	....	481,373
September	35,462	24,576	60,038	48,030	79,806	....	31,776	449,597
October	27,995	18,749	46,744	37,395	....	37,395	....	486,992
Total	501,899	262,418	764,317	611,453	718,252	62,759	232,558	....

NORTH SASKATCHEWAN IRRIGATION PROJECT
WATER SUPPLY TABLE No. 3

Using Red Deer and Clearwater rivers only, without river storage. Possible to irrigate a total area of 570,000 acres

Maximum capacity from Red Deer river, 3,700 c.f.s.. Total gross capacity,
Maximum capacity from Clearwater river, 1,600 c.f.s. . 5,300 c.f.s.

Irrigation factor........................80%
Net "Duty of Water"................1·5 feet.
Total losses..........................43% of gross supply.

Irrigations, May, Aug., Sept., 2 inches, June and July 6 inches.
Regulating reservoir at Sullivan lake.

NORTH SASKATCHEWAN IRRIGATION PROJECT

TABLE—Showing available water supply from Red Deer and Clearwater rivers, without river storage, sufficient to irrigate 570,000 acres.

Net Duty of Water, 18″ per Acre. Irrigable Area, 570,000 Acres

Period	Water Diverted from Rivers in Acre-feet				Gross Required Sullivan Lake	Operation of Sullivan Lake		
	Drawn from Red Deer	Drawn from Clear-water	Total: Gross at Intakes	80 per cent of Total: Gross Available Sullivan Lake		To Storage	From Storage	Balance in Sullivan Lake
1914					Acre-feet	Acre-feet	Acre-feet Est.	Acre-feet
								300,000
May	111,179	42,801	153,980	123,184	106,443	16,741	....	316,741
June	184,140	74,554	258,694	206,955	319,327	....	112,372	204,369
July	138,423	79,820	218,243	174,594	319,327	....	144,733	59,636
August	74,350	45,076	119,426	95,541	106,443	....	10,902	48,734
September	59,395	33,328	92,723	74,178	106,443	....	32,265	16,469
October	82,341	34,008	116,349	93,079	....	93,079	....	109,548
Total	649,828	309,587	959,415	767,531	957,983	....	....	....

NORTH SASKATCHEWAN IRRIGATION PROJECT—WATER SUPPLY TABLE No. 3—Continued.

Period	Water Diverted from Rivers in Acre-feet				Gross at Sullivan Lake Required by Area	Operation of Sullivan Lake Reservoir		
	Drawn from Red Deer	Drawn from Clear-water	Total	80 per cent of Total				
			Gross at Intakes	Gross Available Sullivan Lake Reservoir		To Storage	From Storage	Balance in Sullivan Lake Reservoir
1915								
May	191,100	81,576	272,676	218,141	106,443	111,698	....	221,246
June	219,780	95,040	314,820	251,856	319,327	....	67,471	153,775
July	227,106	98,208	325,314	260,251	319,327	....	59,076	94,699
August	227,106	98,208	325,314	260,251	106,443	153,808	....	248,507
September	214,632	86,724	301,356	241,085	106,443	134,642	....	383,149
October	178,623	59,993	238,616	190,893	....	190,893	....	574,042
Total	1,258,347	519,749	1,778,096	1,422,477	957,983	....	....	....
1916								
May	161,903	60,830	222,733	178,186	106,443	71,743	....	645,785
June	219,780	95,040	314,820	251,856	319,327	....	67,471	578,314
July	227,106	98,208	325,314	260,251	319,327	....	59,076	519,238
August	223,542	98,108	321,650	257,320	106,443	150,877	....	670,115
September	217,404	90,288	307,692	246,154	106,443	139,711	....	809,826
October	200,032	67,888	267,920	214,336	....	214,336	....	1,024,162
Total	1,249,767	510,362	1,760,129	1,408,103	957,983	....	....	....
1917								
May	215,226	85,734	300,960	240,768	106,443	134,325	....	1,158,487
June	219,780	95,040	314,820	251,856	319,327	....	67,471	1,091,016
July	212,706	94,743	307,449	245,959	319,327	....	73,368	1,017,648
August	121,387	66,965	188,352	150,682	106,443	44,239	....	1,061,887
September	106,815	57,308	164,123	131,298	106,443	24,855	....	1,086,742
October	86,826	42,186	129,012	103,210	....	103,210	....	1,189,952
Total	962,740	441,976	1,404,716	1,123,773	957,983	....	....	....
1918								
May	110,566	43,974	154,540	123,632	106,443	17,189	....	1,207,141
June	183,741	77,420	261,161	208,929	319,327	....	110,398	1,096,743
July	107,922	60,940	168,862	135,090	319,327	....	184,237	912,506
August	102,695	56,144	158,839	127,071	106,443	20,628	....	933,134
September	73,438	39,278	112,716	90,173	106,443	....	16,270	916,864
October	53,751	29,458	83,209	66,567	....	66,567	....	983,431
Total	632,113	307,214	939,327	751,462	957,983	....	....	....
1919								
May	120,895	43,600	164,495	131,596	106,443	25,153	....	1,008,584
June	102,774	40,944	143,718	114,974	319,327	....	204,353	804,231
July	78,531	43,170	121,701	97,361	319,327	....	221,966	582,265
August	115,096	65,244	180,340	144,272	106,443	37,829	....	620,094
September	62,787	44,514	107,301	85,841	106,443	....	20,602	599,492
October	34,567	27,429	61,996	49,597	....	49,597	....	649,089
Total	514,650	264,901	779,551	623,641	957,983	....	....	....
1920								
May	215,226	84,289	299,515	239,612	106,443	133,169	....	782,258
June	190,717	92,070	282,787	226,230	319,327	....	93,097	689,161
July	213,246	96,426	309,672	247,738	319,327	....	71,589	617,572
August	95,440	62,108	157,548	126,038	106,443	19,595	....	637,167
September	42,734	34,934	77,668	61,134	106,443	....	44,309	592,858
October	28,348	22,221	50,569	40,455	....	40,455	....	633,313
Total	785,711	392,048	1,177,759	942,207	957,983	....	....	....
1921								
May	152,873	65,023	217,896	174,317	106,443	67,874	....	701,187
June	148,850	71,222	220,072	176,058	319,327	....	143,269	557,918
July	105,431	62,398	167,829	134,263	319,327	....	185,064	372,854
August	74,300	47,676	121,976	97,581	106,443	....	8,862	363,992
September	35,462	24,576	60,038	48,030	106,443	....	58,413	305,579
October	27,995	18,749	46,744	37,395	....	37,395	....	342,974
Total	544,911	289,644	834,555	667,644	957,983	....	....	....

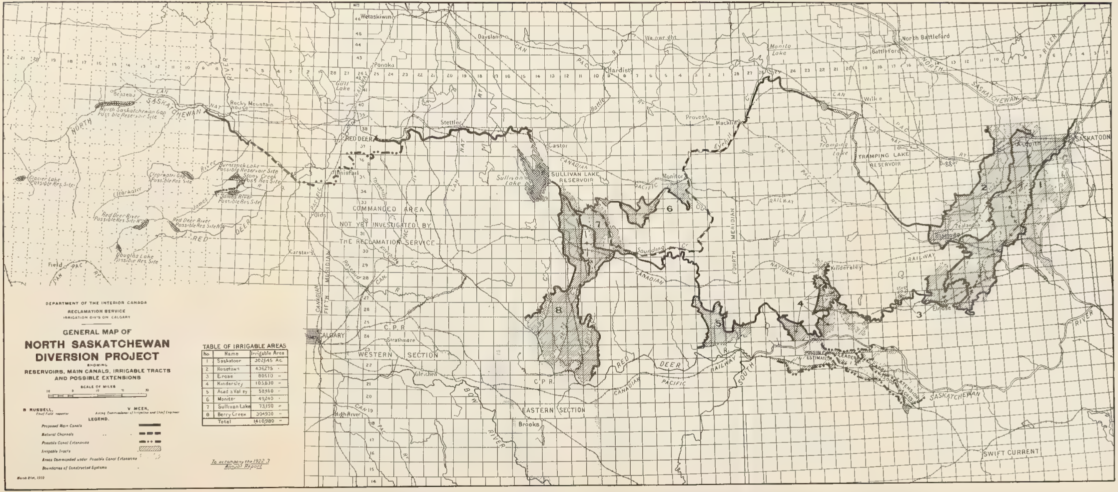


TABLE OF IRRIGABLE AREAS

No.	Name	Irrigable Area
1	Saskatoon	302,645 Ac.
2	Rosetown	436,275 "
3	Elrose	80,610 "
4	Kindersley	105,630 "
5	Acadia Valley	58,460 "
6	Monitor	49,240 "
7	Sullivan Lake	73,190 "
8	Berry Creek	304,930 "
	Total	1,410,980 "

ALKALI TEST PLOTS AT MAPLE CREEK, SASKATCHEWAN

In order to demonstrate the effect of irrigation on heavy clay soil having a high alkali content, it was decided to make a series of experiments under actual field conditions. A number of plots were located on the outskirts of the town of Maple Creek, which, after inspection by Dr. Shutt, Dominion Chemist, appeared from surface conditions to be suitable for the purpose. Arrangements were made with the owner of these lots for a suitable lease, and with the town authorities for the water supply. Upon Dr. Shutt's suggestion the land was divided into three parts, each to receive different cultivation as follows:—

1. No cultivation—the prairie sod to be left undisturbed and in its virgin state.
2. Occasional cultivation—land to be broken and seeded to cultivated grasses.
3. Thorough cultivation—land to be broken and seeded to grains.

Since the space available permitted the establishment of six plots, it was decided to divide the land accordingly, and conduct check tests wherein each would receive identical irrigations. This system would assist materially in eliminating any doubt or error arising in the deductions.

Tests in each plot were conducted during the past season, and one additional will be started next spring. This makes six tests being conducted under each of the three methods of soil treatment or cultivation, all receiving the same irrigations. The deductions possible, after a sufficient period of time, from these eighteen tests conducted under slightly different conditions of soil structure and chemical constituents, should be conclusive and will certainly be valuable.

The site chosen for the plots consisted of virgin prairie. The parts to be cultivated were ploughed in the middle of May. Heavy rains at this time delayed the ploughing, discing, harrowing, and floating, but the soil ultimately worked up very smoothly and formed a good seed bed.

To ensure an accurate and even application of water, each cultivated plot was carefully levelled. All were surrounded by a dyke eight-tenths of a foot high and three feet wide, a portion of the earth for these dykes being borrowed from the rear end of the lots. A 4-foot path was left down the centre for working purposes.

In order to make the data as complete as possible, evaporation, temperature and precipitation records were obtained. For the evaporation a standard pan four feet in diameter and eighteen inches deep was used. It has been set in the ground at the rear of the lots. A standard glazed gauge was read daily, and checked by carefully recording the amount of water added from time to time. The temperature and precipitation records were supplied by the local meteorological observer.

The data compiled are as follows:—

Evaporation, Precipitation, and Temperature Records at Maple Creek, Sask., for 1922

Month	Evaporation in Inches	Precipitation in Inches	Mean Max. Temperature	Mean Min. Temperature	Mean Temperature for Month
April	....	0·54	49·3	29·9	39·6
May	....	2·09	63·1	40·3	51·7
June	a 4·0	0·51	76·8	51·4	64·1
July	5·8	0·90	78·6	50·5	64·6
August	5·0	0·91	79·3	52·7	66·0
Sept	4·9	0·86	71·1	45·9	58·5
Oct	3·7	0·03	58·4	33·5	46·0
Av. April to Sept	....	....	....	....	57·4
Total April. to Sept	b . 19·7	5·81	....	....	....

(a) = records for June 12-30.
(b) = total for period June 12 to Sept. 30.
Date of last frost, May 11, temperature 29°
Date of first frost, October 5, temperature 30°
Time between frosts 147 days.
NOTE:—In order to compare records with those obtained at other places, only those for period April 1 to September 30 were used in averages or totals.

On May 27, 1922, the plots were seeded, and as the muddy soil precluded the possibility of using a seed drill, the seed was scattered broadcast by hand and covered with a rake. This proved unsatisfactory and in future the seeding should be done only when the soil is in a suitable condition for the operation of a drill.

Plots "A" and "F" were left in native grasses and not seeded. Plots "B" and "E" were seeded with an equal mixture of brome and western rye grass, 28 pounds per acre, and plots "C" and "D" were seeded with wheat, 1·43 bushels per acre.

The heavy nature and high alkali content of the soil, together with the scarcity of water in the Maple Creek valley, were taken into consideration when determining the depths of the respective irrigations and the total depth of water to be applied. It has been generally thought that this soil would absorb water very slowly and that, because of its retentive nature, it would require but little water to mature a crop. Furthermore, it was considered that the amount usually applied to other and lighter soils would sour this heavy soil and cause a dangerous rise of alkali. For this reason fourteen inches were deemed a suitable total depth to apply to the test plots.

As to suitable depths for the different irrigations, it was considered that four-inch applications would be all the soil could absorb within a reasonable time, and as a certain amount of water would be lost by evaporation, while lying on the surface, it was decided to try at first a six-inch irrigation to determine this point. Such an application was found to be absorbed in one and one-half days and seems to be practicable, especially on lands where a dyking system of irrigation is possible.

Since the primary purpose of the test plots was to determine the productivity of the Maple Creek flats, it was decided to henceforth apply a six-inch irrigation early in the spring and two four-inch irrigations later in the season. This was impossible in 1922, owing to the necessity of first getting the land broken and prepared. Now that the plots are in readiness for next year's operations early irrigation will be practicable.

During the season of 1922 an irrigation of 6 inches was given on June 9, and on July 12 and August 7 two 4-inch applications were applied. At any time during this period the subsoil was sufficiently moist to be packed into a ball, although small surface cracks appeared upon the surface of the land. The soil was, contrary to expectations, very free from excessive baking after any of the three irrigations. Its physical condition throughout the summer appeared to show that such soils may be economically worked under practical farming conditions.

The native grass upon plots "A" and "F" maintained a healthy appearance all summer, although it was not thick, and only attained a height of 20 inches. It is generally conceded, in that district, that two or three years are required to develop a wild hay meadow. Some timothy was noted among the wild grasses, and the foxtail, as usual, had a prolific growth.

Two plots, "B" and "E," were seeded to a mixture of bromus and rye grass. The seeds were slow to germinate, although a very good catch eventually resulted. The grass did not grow to a sufficient height for hay, but a better growth should result in the second season. These plots were lightly harrowed in the fall.

The remaining two plots, "C" and "D," were seeded to wheat. Since the seed was spread broadcast by hand and covered with a rake, the stand was somewhat uneven. The grain stooled out very little, and did not attain a height of more than 2 feet. The straw was of a healthy colour. The heads were short and the kernels of wheat were fairly well filled, hard, and would grade No. 1. These two plots were fall-ploughed on September 20. The soil was dry and worked up splendidly under the harrow. Both plots were left in a smooth condition for next season's operations. The past year's cultivation no doubt opened up and left the soil in a better condition for another crop than it was for the one just harvested.

REPORT ON DUTY OF WATER INVESTIGATIONS FOR 1922, BROOKS EXPERIMENTAL STATION

The season of 1922 was more favourable for crop growth than any season since 1917; this was due principally to the June precipitation, which was above the average and well distributed, and to the absence of destructive hot winds, such as have occurred during May and June of previous seasons. The month of April was cold and wet, having a precipitation of 1·94 inches. The land did not dry out sufficiently to permit of cultural operations during the month. Frost occurred on twenty-three nights in April, the last frost of the month being recorded on the 26th. The mean temperature was 41°.

During May light frosts occurred on the 10th, 11th and 23rd. The precipitation was 1·26 inches, and the mean temperature 52·7 degrees; this, with the exception of 53·1 degrees in 1919, is the highest temperature for May since 1917.

June had a mean temperature of 62·2 degrees and a precipitation of 2·09 inches; the temperature was about normal, but the precipitation was the highest since 1916. Rain fell on the 6th, 8th, 12th, 15th, 16th, 19th, 20th and 29th. The amount and distribution of this rainfall produced vigorous growth of all alfalfa and clover seedlings, and very materially aided the germination and early growth of grain crops.

July had a mean temperature of 64·9 degrees and a precipitation of 0·33 inch; this is the smallest precipitation recorded since 1915. August had a mean temperature of 66 degrees, the highest recorded since 1916. The precipitation was 1·7 inches. The month was very hot and sultry with some hot winds—very good weather for corn and alfalfa seed. September had a mean temperature of 57 degrees, which was the maximum recorded since the station was established in 1917. The precipitation was 1·12 inches. Two degrees of frost was recorded on the 26th.

The total precipitation, April to September inclusive, was 8·44 inches.

The mean temperature for the same period was 57·4°.

In 1922, 5·29 inches of rain fell between April 1 and June 30. The nearest approach to this amount was in 1920 when 3·56 inches fell in the same time. This increase in rainfall during the three early season months is directly responsible for the better crop yields of this year.

The results of the past season's work are given in the following tables.

In studying the tables it is to be noted that the column "Total Depth Received" is the sum of the "Duty of Water" or depth applied and the "Precipitation." The column "Total Depth Used in Growing the Crop" shows the depth of water which actually assisted in the growing of the crop as determined by soil moisture tests.

During 1922, the water requirement of wheat was determined under four different conditions of soil fertility: (1) as the second crop following a three-year ley of alfalfa; (2) as the third crop following a two-year ley of alsike clover; (3) as the next crop after peas and (4) as the third crop following a two-year ley of grass. (See diagram No. 1).

The water requirement of oats was determined under four conditions of soil fertility, barley, under three, potatoes under two, and flax under one.

The following tables show the rotation schedule adopted to maintain the general fertility of the farm, and to ensure that each crop series will have, from year to year, the same conditions of soil fertility.

Rotation A. Alfalfa five years, potatoes, wheat, flax.
" B. Alsike clover four years, hoed crop, oats, wheat, oats.
" C. Grass three years, potatoes, barley, wheat.
" D. Red clover two years, oats, barley.
" E. Peas, wheat, oats, barley.

By following this schedule there are in each year grain crops (either wheat, oats or barley) coming immediately after legumes or grasses, second year after legumes and third year after legumes, and practical evidence is afforded, that a crop growing on a fertile soil requires less water to produce a given yield than if grown upon a soil from which the available plant food has been exhausted by successive cropping without the use of legumes or the addition of organic matter.

Wheat.—In rotation "A" the maximum yield, 65·6 bushels per acre was produced under a total depth received of 1·9 feet.

In rotation "B" the maximum yield, 58·6 bushels per acre, was produced under a total depth received of 1·24 feet.

In rotation "E" the maximum yield, 56·5 bushels per acre, was produced under a total depth received of 2·22 feet.

In rotation "C" the maximum yield 43·5 bushels per acre was produced under a total depth received of 2·57 feet.

Summarizing the results from the four wheat series, it is shown that the maximum yields were produced with an average total depth received of 1·98 feet, of which 0·57 foot was rainfall. In rotations A, B, and E the application of additional amounts of water produced a decrease in yield. In rotation "C" the maximum yield coincides with the maximum depth received. The maximum yield of the four series, 65·6 bushels per acre, under a total depth received of 1·9 feet was grown on land that had been in alfalfa in 1920 and in potatoes in 1921.

Oats.—In rotation "D" the maximum yield, 131·2 bushels per acre, was produced under a total depth received of 1·9 feet. In rotation "B" the maximum yield, 134 bushels per acre, was produced under a total depth received of 2·62 feet. In rotation "E" the maximum yield, 100·4 bushels per acre, was produced under a total depth received of 1·9 feet. In rotation "B1" the maximum yield, 109·5 bushels per acre, was produced under a total depth received of 1·57 feet.

Summarizing the results from the four oat series it is shown that the maximum yields were produced with an average total depth received of 2 feet, of which 0·57 foot was rainfall.

The maximum yield of the four series, 134 bushels per acre, under a total depth received of 2·62 feet, was grown on land that had been in alsike clover in 1920, and in corn in 1921.

Barley.—In rotation "D" the maximum yield, 63 bushels per acre, was produced under a total depth received of 1·57 feet. In rotation "C" the maximum yield, 50 bushels per acre was produced under a total depth received of 2·22 feet. In rotation "E" the maximum yield, 44 bushels per acre was produced under a total depth received of 1·88 feet.

Summarizing the results from the three barley series it is shown that the maximum yields were produced under an average total depth received of 1·89 feet, of which 0·56 foot was rainfall.

The maximum yield of the three series, 63 bushels per acre, under a total depth received of 1·57 feet, was grown on land that had been in red clover in 1920 and in oats in 1921.

Flax.—In rotation "A" the maximum yield, 31·1 bushels per acre was produced under a total depth received of 2·25 feet, of which 0·58 foot was rainfall.

Alfalfa Hay.—In rotation "A1," 1920 seeding, the maximum yield 7·56 tons per acre, was produced under a total depth received of 2·61 feet, of which 0·6 foot was rainfall.

In rotation "A2," 1921 seeding, the maximum yield 6·08 tons per acre, was produced under a total depth received of 3·11 feet.

In rotation "B1," 1920 seeding, the maximum yield, 7·1 tons per acre, was produced under a total depth received of 3·11 feet. There was no yield on the non-irrigated plot.

In rotation "B2," 1920 seeding, the maximum yield 5·91 tons per acre, was produced under a total depth received of 2·61 feet.

A summarization of the results of the four alfalfa series shows that the maximum yields were produced under an average depth received of 2·86 feet.

Grass Hay.—The maximum yield of grass hay, 2·84 tons per acre, was produced under a total depth received of 1·96 feet of which 0·46 foot was received as rainfall. The dry plot produced 1·48 tons per acre.

Field Corn.—The maximum yield of field corn, 17·72 tons green weight per acre, was produced under a total depth received of 1·7 feet, of which 0·7 foot was received as rainfall. The dry plot produced 9·65 tons per acre.

Peas.—The maximum yield of peas, 56·8 bushels per acre, was produced under a total depth received of 2·37 feet, of which 0·7 foot was rainfall. The dry plot produced 9·7 bushels per acre.

Pototoes.—In rotation "A" the maximum yield, 429·4 bushels per acre, was produced under a total depth received of 1·6 feet, of which 0·77 foot was received as rainfall. The non-irrigated plot produced 100·4 bushels per acre.

In rotation "C" the maximum yield, 297 bushels per acre was produced under a total depth received of 1·6 feet, of which 0·77 foot was received as rainfall.

Alfalfa Seed Production.—The maximum yield of alfalfa seed, 11·9 bushels per acre, was produced under a total depth received of 2·03 feet, of which 0·7 foot was received as rainfall. This yield was produced on plot 102F which is seeded in drills 7 inches apart. It is coincident with the maximum depth applied.

The maximum yield from the plot 107 series, in which the alfalfa is seeded in rows 36 inches apart, was 6·47 bushels per acre; this yield was produced under a total depth received of 1·7 feet of which 0·7 foot was received as rainfall.

It was impossible to get a catch of alfalfa on plot 106, on which the alfalfa was to be seeded in hills 36 inches apart, therefore no data are available for that method of planting for 1922.

WHEAT (MARQUIS), 1922

IRRIGATION EXPERIMENT STATION, BROOKS, ALBERTA — PLOT SERIES RECORD

Plot No.	Area Acres	Irrigation Date and Depth Applied in Acre-feet per Acre: June						July					August		Duty of Water	Rainfall April First to Harvest	Total Depth Received	Total Depth used in Growing Crop	Yield per Acre	—
		8	19	21	27	29		5	10	18	24		1	3						
Rotation A—															Ft.	Ft.	Ft.	Ft.	Bus.	Cut
54 A	0·0228														0·00	0·55	0·55	0·87	30·6	Aug. 6
B	0·0302		0·33												0·33	0·55	0·88	1·10	44·8	" 6
C	0·0302		0·33					0·34							0·67	0·57	1·27	1·16	56·8	" 19
D	0·0311	0·33			0·34					0·33					1·00	0·57	1·57	1·57	62·3	" 19
E	0·0302	0·33			0·34					0·33			0·34		1·33	0·57	1·90	1·82	65·6	" 23
55 A	0·0314	0·33		0·34				0·33			0·34			0·33	1·67	0·57	2·24	1·99	63·5	" 23
B	0·0307	0·33		0·34		0·33			0·33		0·34			0·33	2·00	0·57	2·57	2·40	62·3	" 23
C	0·0314		0·50					0·50							1·00	0·57	1·57	1·61	49·0	" 19
D	0·0297	0·50			0·50					0·50					1·50	0·57	2·07	2·09	56·5	" 23
E	0·0289	0·50			0·50					0·50			0·50		2·00	0·57	2·57	1·99	61·2	" 23
		June						July					August							
		8	10	19	21	26	30	6	10	17	24		2							
Rotation B—																				
70 A	0·0130														0·00	0·55	0·55	0·68	7·45	Aug. 11
B	0·0244			0·33											0·33	0·57	0·90	1·15	42·5	" 19
C	0·0253			0·33				0·34							0·67	0·57	1·24	1·74	58·6	" 23
D	0·0248	0·33				0·33				0·34					1·00	0·57	1·57	1·96	55·7	" 23
E	0·0263		0·33			0·34				0·33			0·34		1·34	0·57	1·91	2·16	55·1	" 23
71 A	0·0274	0·33			0·34			0·33			0·34		0·33		1·67	0·57	2·24	2·16	47·4	" 23
B	0·0282	0·33			0·34		0·33		0·34		0·33		0·33		2·00	0·57	2·57	2·42	55·5	" 23
C	0·0278			0·50				0·50							1·00	0·57	1·57	1·69	51·9	" 23
D	0·0283	0·50				0·50				0·50					1·50	0·57	2·07	2·42	45·6	" 23
E	0·0285	0·50				0·50				0·50			0·50		2·00	0·57	2·57	2·79	42·4	" 23

WHEAT (MARQUIS), 1922—*Concluded*

IRRIGATION EXPERIMENT STATION, BROOKS, ALBERTA — PLOT SERIES RECORD

Plot No.	Area Acres	Irrigation: Date and Depth Applied in Acre-feet per Acre — June 12	June 17	June 23	June 29	June	June	July 3	July 7	July 11	July 21	July 27	August 3	August 8	Duty of Water	Rainfall April First to Harvest	Total Depth Received	Total Depth used in Growing Crop	Yield per Acre	—
															Ft.	Ft.	Ft.	Ft.	Bus.	Cut
Rotation E—																				
14 B	0·098														0·00	0·55	0·55	0·61	3·9	Aug. 8
15	0·234		0·33												0·33	0·55	0·88	0·81	19·7	" 8
16	0·234		0·33						0·34						0·67	0·55	1·21	1·22	39·4	" 8
17	0·230	0·33			0·34						0·33				1·00	0·55	1·55	1·72	47·0	" 16
18	0·235	0·33			0·34						0·33		0·34		0·33	0·55	1·88	1·93	46·0	" 16
19	0·233	0·33		0·34					0·33			0·34		0·33	1·67	0·55	2·22	2·28	56·5	" 16
20	0·228	0·33		0·34				0·33		0·34		0·33		0·34	2·00	0·55	2·55	2·64	55·5	" 16
11	0·232		0·50						0·50						1·00	0·57	1·57	1·57	46·7	" 19
12	0·234	0·50			0·50						0·50				1·50	0·57	2·07	2·14	48·9	" 19
13	0·234	0·50			0·50						0·50		0·50		2·00	0·57	2·57	2·26	51·5	" 19
14 A	0·114	0·34		0·33					0·34			0·33		0·34	1·67	0·55	2·22	2·26	55·0	" 16

Plot No.		June 7	June 19	June 21	June	June 26	June	July 5	July 10	July 18	July 24	July 31	July	Aug. 3						
Rotation C—																				
83 A	0·0263														0·00	0·55	0·55	0·87	28·3	Aug. 14
B	0·0352		0·33												0·33	0·55	0·88	1·00	28·8	" 14
C	0·0344		0·33					0·34							0·67	0·57	1·24	1·01	37·3	" 17
D	0·0348	0·33				0·34				0·33					1·00	0·57	1·57	1·38	38·4	" 19
E	0·0350	0·33				0·34				0·33		0·34			1·34	0·57	1·91	1·90	38·9	" 19
84 A	0·0331	0·33		0·34				0·33			0·34			0·33	1·67	0·57	2·24	1·83	42·5	" 17
B	0·0333	0·33		0·34		0·33			0·33		0·34			0·33	2·00	0·57	2·57	1·67	36·9	" 17
C	0·0336		0·50					0·50							1·00	0·57	1·57	1·41	38·8	" 17
D	0·0342	0·50				0·50				0·50					1·50	0·57	2·07	2·06	36·9	" 21
E	0·0344	0·50				0·50				0·50		0·50			2·00	0·57	2·57	2·34	43·5	" 21

OATS (BANNER) 1922

Plot No.	Acres	June 9	June 16	June 21	June 26	June	June 30	July	July 5	July 10	July	July 20	July 22	August 1	August	August 4	....	....	....	....	......	
Rotation D—																						
78 A	0·0035																0·00	0·57	0·57	0·94	15·1	Aug. 21
B	0·0330		0·33														0·33	0·57	0·90	0·68	101·5	" 21
C	0·0328		0·33						0·34								0·67	0·57	1·24	1·16	82·4	" 21
D	0·0322	0·33			0·34							0·33					1·00	0·57	1·57	1·13	94·4	" 21
E	0·0318	0·33			0·34							0·33		0·33			1·33	0·57	1·90	1·64	131·2	" 21
79 A	0·0308	0·33		0·34					0·33				0·33			0·34	1·67	0·57	2·24	2·16	112·0	" 21
B	0·0329	0·33		0·34			0·33			0·33			0·33			0·34	2·00	0·57	2·57	1·95	118·0	" 21
C	0·0324		0·50						0·50								1·00	0·57	1·57	1·32	116·5	" 21
D	0·0333	0·50					0·50					0·50					1·50	0·57	2·07	2·07	116·2	" 21
E	0·0328	0·50					0·50					0·50		0·50			2·00	0·57	2·57	2·54	112·8	" 21

Plot No.		June 8	June 10	June 19	June 23	June 26	June 30	July	July 5	July 10	July 17	July 20	July 24	August	August 1	August 4						
Rotation B—																						
72 A	0·0330																0·00	0·57	0·57	0·76	104·4	Aug. 19
B	0·0308			0·33													0·33	0·61	0·94	0·99	91·0	Sept. 2
C	0·0310			0·33					0·34								0·67	0·61	1·28	1·60	115·5	" 2
D	0·0313		0·33			0·34						0·33					1·00	0·62	1·62	1·99	104·5	" 6
E	0·0320		0·33			0·34						0·33			0·33		1·33	0·62	1·95	2·28	112·8	" 6
73 A	0·0313		0·33		0·34				0·33				0·34			0·33	1·67	0·61	2·28	2·59	108·5	" 2
B	0·0310		0·33		0·34		0·33			0·33			0·34			0·33	2·00	0·62	2·62	2·99	134·0	" 6
C	0·0318			0·50													1·00	0·62	1·62	2·11	111·5	" 6
D	0·0312	0·50				0·50					0·50						1·50	0·62	2·12	2·43	123·2	" 6
E	0·0342	0·50				0·50					0·50				0·50		2·00	0·62	2·62	2·61	128·0	" 6

OATS (BANNER) 1922—*Concluded*

IRRIGATION EXPERIMENT STATON, BROOKS, ALBERTA. PLOT SERIES RECORD

Plot No.	Area Acres	Irrigation Date and Depth Applied in Acre-feet per Acre															Duty of Water	Rainfall Apr. 1 to Harvest	Total Depth Received	Total Depth used in Growing Crop	Yield per Acre	—
		June							July						August							
		12	15	17	20	23	29		3	8	11	21	26		2	8						
Rotation E—																	Ft.	Ft.	Ft.	Ft.	Bus.	Cut
30 A	0·0620																0·00	0·55	0·55	0·57	21·9	Aug. 14
26	0·2330			0·33													0·33	0·55	0·88	0·75	42·0	" 8
25	0·2280			0·33						0·34							0·67	0·57	1·24	1·34	90·3	" 16
24	0·2390	0·33				0·34						0·33					1·00	0·57	1·57	1·73	91·1	" 22
23	0·2390		0·33			0·34						0·33			0·33		1·33	0·57	1·90	1·75	100·4	" 22
22	0·2370	0·33			0·34					0·33			0·33			0·34	1·67	0·57	2·24	1·80	88·5	" 22
21	0·2370	0·33			0·34		0·33			0·33			0·34			0·33	2·00	0·57	2·57	2·28	80·5	" 22
30	0·1660			0·50					0·50								1·00	0·57	1·57	1·54	91·5	" 16
29	0·1930		0·50			0·50					0·50						1·50	0·57	2·07	1·98	88·7	" 22
28	0·2270		0·50			0·50					0·50				0·50		2·00	0·57	2·57	2·41	87·7	" 22
27	0·2350		0·33		0·34				0·33			0·33				0·34	1·67	0·57	2·24	2·28	99·5	" 22
		June							July						August							
		8	10	16	19	23	27	30	5	10	17	19	24	25	1	4						
Rotation B 1—																						
68 A	0·0084																0·00	0·55	0·55	0·36	10·3	Aug. 14
B	0·0346				0·33												0·33	0·55	0·88	1·17	53·5	" 14
C	0·0370				0·33				0·34								0·67	0·55	1·22	1·56	83·8	" 14
D	0·0353	0·33					0·34				0·33						1·00	0·57	1·57	2·14	109·5	" 23
E	0·0357	0·33					0·34				0·33				0·34		1·33	0·57	1·90	1·97	101·0	" 23
69 A	0·0348		0·33			0·34			0·33					0·34		0·33	1·67	0·57	2·24	1·84	93·6	" 23
B	0·0361		0·33			0·34		0·33		0·34			0·33			0·34	2·00	0·57	2·57	2·26	85·5	" 23
C	0·0348			0·50					0·50								1·00	0·55	1·55	1·69	69·5	" 14
D	0·0350	0·50					0·50					0·50					1·50	0·57	2·07	2·17	87·0	" 23
E	0·0335	0·50					0·50					0·50			0·50		2·00	0·57	2·57	2·30	90·0	" 23

BARLEY (O.A.C. 21), 1922

Plot No.	Area Acres	Irrigation Date and Depth Applied in Acre-feet per Acre												Duty of Water	Rainfall Apr. 1 to Harvest	Total Depth Received	Total Depth used in Growing Crop	Yield per Acre	—
		June					July					August							
		9	16	22	26	30	5	10		20	24	1	4						
Rotation D—														Ft.	Ft.	Ft.	Ft.	Bus.	Cut
77 A	0·0267													0·00	0·55	0·55	0·57	3·9	Aug. 14
76A	0·0319		0·33											0·33	0·57	0·90	0·77	49·2	" 16
B	0·0330		0·33				0·34							0·67	0·57	1·24	0·96	55·0	" 16
C	0·0332	0·33			0·34					0·33				1·00	0·57	1·57	1·33	62·0	" 17
D	0·0330	0·33			0·34					0·33		0·33		1·33	0·57	1·90	1·61	61·5	" 17
E	0·0300	0·33		0·34			0·33						0·34	1·67	0·57	2·24	1·94	59·0	" 17
77 B	0·0328	0·33		0·34		0·33		0·33			0·34		0·33	2·00	0·57	2·57	2·21	56·0	" 17
C	0·0325		0·50				0·50							1·00	0·57	1·57	1·33	63·0	" 17
D	0·0328	0·50			0·50					0·50				1·50	0·57	2·07	2·13	62·0	" 17
E	0·0313	0·50			0·50					0·50		0·50		2·00	0·57	2·57	2·67	58·4	" 17
		June					July					August							
		7	19	21	26	29	5	10	18	24	31	3							
Rotation C—																			
86 A	0·0097													0·00	0·55	0·55	0·69	19·6	Aug. 14
B	0·0348		0·33											0·33	0·55	0·88	0·87	26·2	" 11
C	0·0350		0·33				0·34							0·67	0·55	1·22	1·10	36·8	" 11
D	0·0345	0·33			0·34				0·33					1·00	0·55	1·55	1·30	41·0	" 14
E	0·0346	0·33			0·34				0·33		0·33			1·33	0·55	1·88	1·57	49·5	" 14
85 A	0·0350	0·33		0·34			0·33			0·33		0·34		1·67	0·55	2·22	1·87	50·2	" 14
B	0·0346	0·33		0·34		0·33		0·33		0·33		0·34		2·00	0·55	2·55	2·09	37·3	" 14
C	0·0342		0·50				0·50							1·00	0·55	1·55	1·41	32·2	" 14
D	C·0340	0·50			0·50				0·50					1·50	0·55	2·05	1·54	41·7	" 14
E	0·0343	0·50			0·50				0·50		0·50			2·00	0·55	2·55	2·33	46·3	" 14
		June					July					August							
		12	14	17	22	28	3	7	11	22	26	3	8						
Rotation E—																			
32	0·6650													0·00	0·55	0·55	0·45	6·85	Aug. 7
31	0·0835		0·33											0·33	0·55	0·88	0·60	24·80	" 14
36	0·2030			0·33				0·34						0·67	0·55	1·22	0·84	40·40	" 11
37	0·2160	0·33				0·34				0·33				1·00	0·55	1·55	1·45	43·60	" 11
38	0·2060	0·33				0·34				0·33		0·33		1·33	0·55	1·88	1·38	44·00	" 11
39	0·2140	0·33			0·34			0·33			0·33		0·34	1·67	0·55	2·22	1·80	43·30	" 14
40	0·2140	0·33			0·34		0·33		0·33		0·34		0·33	2·00	0·55	2·55	2·44	39·50	" 14
33	0·0675			0·50				0·50						1·00	0·55	1·55	1·62	42·00	" 14
34	0·0680	0·50				0·50				0·50				1·50	0·55	2·05	2·13	43·50	" 14
35	0·0657	0·50				0·50				0·50		0·50		2·00	0·57	2·57	2·24	44·00	" 17
32A	0·1980		0·33		0·34			0·33			0·33		0·34	1·67	0·57	2·24	1·97	42·30	" 17

FLAX (VARIETY), 1922

IRRIGATION EXPERIMENT STATION, BROOKS, ALBERTA. PLOT SERIES RECORD

Plot No. Rotation A	Area Acres	Irrigation Date and Depth Applied in Acre-feet per Acre: June 8	June 17	June 24	June 27	June 30	July 6	July 10	July 18	July 25	August 2	August 7	Duty of Water	Rainfall April First to Harvest	Total Depth Received	Total Depth used in Growing Crop	Yield per Acre	Remarks
													Ft.	Ft.	Ft.	Ft.	Bus.	Cut
52A	0·0319	....	....	....	....	....	....	....	....	....	....	....	0·00	0·55	0·55	0·44	1·01	Aug. 11
B	0·0331	....	0·33	....	....	....	....	....	....	....	....	....	0·33	0·55	0·88	0·76	3·35	" 11
C	0·0335	....	0·33	....	....	....	0·34	....	....	....	....	....	0·67	0·55	1·22	1·02	5·33	" 11
D	0·0330	0·33	....	....	0·34	....	....	....	0·33	....	....	....	1·00	0·57	1·57	1·54	18·2	" 23
E	0·0330	0·33	....	....	0·34	....	....	....	0·33	....	0·34	....	1·33	0·58	1·91	1·77	20·7	" 28
53A	0·0328	0·33	....	0·34	....	....	0·33	....	....	0·34	....	0·33	1·67	0·58	2·25	2·11	31·1	" 28
B	0·0338	0·33	....	0·34	....	0·33	....	0·34	....	0·33	....	0·34	2·00	0·58	2·58	2·46	27·9	" 28
C	0·0332	....	0·50	....	....	....	0·50	....	....	....	....	....	1·00	0·57	1·57	1·49	17·4	" 23
D	0·0330	0·50	....	....	0·50	....	....	....	0·50	....	....	....	1·50	0·58	2·08	1·58	30·9	" 28
E	0·0329	0·50	....	....	0·50	....	....	....	0·50	....	0·50	....	2·00	0·58	2·58	1·79	27·7	" 28

ALFALFA (GRIMM), 1922

IRRIGATION EXPERIMENT STATION, BROOKS, ALBERTA. PLOT SERIES RECORD

Plot No. Rotation A1	Area Acres	Irrigation Date and Depth Applied in Acre-feet per Acre: June 9	June 21	June 24	July 17	July 19	July 25	July 31	August 4	August 7	August 15	Duty of Water	Rainfall April First to Harvest	Total Depth Received	Total Depth used in Growing Crop	Yield per Acre	Remarks
												Ft.	Ft.	Ft.	Ft.	Tons	
45A	0·0292	....	....	....	....	....	....	....	....	....	....	0·00	0·61	0·61	1·88	4·45	
B	0·0307	....	....	0·50	....	....	....	....	....	....	....	0·50	0·61	1·11	2·05	4·52	
C	0·0310	....	0·50	....	....	0·50	....	....	....	....	....	1·00	0·61	1·61	2·09	6·13	
D	0·0325	0·50	....	....	0·50	....	....	0·50	....	....	....	1·50	0·61	2·11	2·37	7·43	
E	0·0324	0·50	....	0·50	....	0·50	....	....	....	....	....	1·50	0·61	2·11	2·86	7·52	
47A	0·0318	0·50	....	0·50	0·50	....	0·50	....	0·50	....	....	2·50	0·61	3·11	2·90	6·79	
B	0·0328	0·50	....	0·50	0·50	....	0·50	....	....	0·50	0·50	3·00	0·61	3·61	3·39	6·88	
C	0·0327	0·33	....	0·34	0·33	....	....	....	....	....	....	1·00	0·61	1·61	1·98	6·67	
D	0·0322	0·33	....	0·34	0·33	....	0·33	....	....	0·34	....	1·67	0·61	2·28	1·90	6·95	
E	0·0320	0·33	....	0·34	0·33	....	0·33	....	....	0 34	0·33	2·00	0·61	2·61	2·55	7·56	

47 C and 45 E last scheduled irrigation not applied.

Plot No. Rotation A2		June	June 8	June 17	June 23	July	July 17	July 26	August 3	August 15	August						
												Ft.	Ft.	Ft.	Ft.	Tons	
8A	0·0310	....	....	....	....	....	....	....	....	....	....	......	0·61	0·61	0·82	0·00	
B	0·0312	....	....	....	0·50	....	....	....	....	....	....	0·50	0·61	1·11	1·41	3·10	
C	0·0320	....	....	0·50	....	....	0·50	....	....	....	....	1·00	0·61	1·61	2·04	3·78	1921
D	0·0312	....	0·50	....	....	....	0·50	0·50	....	....	....	1·50	0·61	2·11	2·57	4·93	
E	0·0328	....	0·50	....	0·50	....	0·50	....	0·50	....	....	2·00	0·61	2·61	2·33	5·92	Seed-
49A	0·0300	....	0·50	....	0·50	....	0·50	0·50	0·50	....	....	2·50	0·61	3·11	2·98	6·08	
B	0·0310	....	0·50	....	0·50	....	0·50	0·50	0·50	0·50	....	3·00	0·61	3·61	3·19	5·46	ing
C	0·0316	....	0·33	....	0·34	....	0·33	....	....	....	....	1·00	0·61	1·61	1·97	4·70	
D	0·0380	....	0·33	....	0·34	....	0·33	0·34	0·33	....	....	1 67	0 61	2 28	2 50	5 91	
E	0 0312	....	0 33	....	0 34	....	0 33	0 34	0 33	0 33	....	2 00	0·61	2·61	2·79	6·04	

49 C last scheduled irrigation not applied.

Plot No. Rotation B1		June 7	June 16	June 22	July 17	July 24	July 27	July	August 1	August 4	August 15						
												Ft.	Ft.	Ft.	Ft.	Tons	
62A	....	....	....	....	....	....	....	....	....	....	....	0·00	0·61	0·61	0·72	0·00	
B	0·0364	....	....	0·50	....	....	....	....	....	....	....	0·50	0·61	1·11	1·16	1·48	
C	0·0364	....	0·50	....	0·50	....	....	....	....	....	....	1·00	0·61	1·61	1·65	2·05	
D	0·0358	0·50	....	....	0·50	....	0·50	....	....	....	....	1·50	0·61	2·11	2·05	3·54	
E	0·0343	0·50	....	0·50	0·50	....	....	....	0·50	....	....	2·00	0·61	2·61	2·62	4·91	
63A	0·0355	0·50	....	0·50	0·50	0·50	....	....	....	0·50	....	2·50	0·61	3·11	2·71	7·10	
B	0·0350	0·50	....	0·50	0·50	0·50	....	....	....	0·50	0·50	3·00	0·61	3·61	2·86	7·05	
C	0·0365	0·33	....	0·34	0·33	....	....	....	....	....	....	1·00	0·61	1·61	2·34	5·95	
D	0·0353	0·33	....	0·34	0·33	0·34	....	....	....	0·33	....	1·67	0·61	2·28	2·40	6·70	
E	0·0354	0·33	....	0·34	0·33	0·34	....	....	....	0·33	0·33	2·00	0·61	2·61	2·41	6·71	

63 C last scheduled irrigation not applied.

ALFALFA (GRIMM) 1922—Continued

IRRIGATION EXPERIMENT STATION, BROOKS, ALBERTA — PLOT SERIES RECORD

Plot No. Rotation B2	Area Acres	Irrigation: Date and Depth Applied in Acre-feet per Acre — June 7	June 16	June 22	July 18	July 24	July 27	July	August 1	August 4	August 15	Duty of Water	Rainfall April First to Harvest	Total Depth Received	Total Depth used in Growing Crop	Yield per Acre	Remarks
												Ft.	Ft.	Ft.	Ft.	Tons	
64A	0·0353											0·00	0·61	0·61	1·03	0·00	
B	0·0344			0·50								0·50	0·61	1·11	1·40	3·07	
C	0·0360		0·50		0·50							1·00	0·61	1·61	2·01	3·72	
D	0·0354	0·50			0·50		0·50					1·50	0·61	2·11	2·62	4·04	
E	0·0348	0·50		0·50	0·50				0·50			2·00	0·61	2·61	2·96	5·00	
65A	0·0347	0·50		0·50	0·50	0·50				0·50		2·50	0·61	3·11	3·40	5·22	
B	0·0335	0·50		0·50	0·50	0·50				0·50	0·50	3·00	0 61	3·61	3·31	5·25	
C	0·0338	0·33		0·34	0·33							1·00	0·61	1·61	1·85	4·80	
D	0·0341	0·33		0·34	0·33	0·34				0·33		1·67	0·61	2·28	2·28	5·30	
E	0·0340	0·33		0·34	0·33	0·34				0·33	0·33	2·00	0·61	2·61	2·44	5·91	

65 C last scheduled irrigation not applied.

MIXED GRASSES (BROME, MEADOW FESCUE, TIMOTHY, WESTERN RYE), 1922

Plot No. Rotation C	Area Acres	Irrigation: Date and Depth Applied in Acre-feet per Acre — June 7	June 17	June 20	June 25	June 30	Duty of Water	Rainfall April First to Harvest	Total Depth Received	Total Depth used in Growing Crop	Yield per Acre	Remarks
							Ft.	Ft.	Ft.	Ft.	Tons	Cut
91–92A	0·0380							0·46	0·46		1·48	July 14
B	0·0384	0·33					0·33	0·46	0·79		2·08	" 14
C	0·0344	0·33		0·34			0·67	0·46	1·13		1·92	" 14
D	0·0328	0·33	0·34		0·33		1·00	0·46	1·46		2·53	" 14
E	0·0290	0·33	0·34		0·33		1·00	0·46	1·46		2·45	" 14
F	0·0289	0·33	0·33	0·34		0·33	1·33	0·46	1·79		2·28	" 14
G	0·0390	0·33	0·33	0·34	0·33	0·34	1·67	0·46	2·13		2·62	" 14
H	0·0450	0·50		0·50			1·00	0·46	1·46		2·22	" 14
K	0·0517	0·50	0·50		0·50		1·50	0·46	1·96		2·84	" 14
L	0·0467	0·50	0·50		0·50	0·50	2·00	0·46	2·46		1·72	" 14

E.F.G. last scheduled irrigation not applied. Rainfall—July 14–Sept. 8,1·91″. Evaporation—July 14–Sept. 8, 6·68″, 0·55″,

CORN (N. W. DENT), 1922

Plot No. Rotation B	Area Acres	Irrigation: Date and Depth Applied in Acre-feet per Acre — June 25	June 30	July 5	July 10	July 19	July 25	August 2	August 7	August 11	August 16	Duty of Water	Rainfall April First to Harvest	Total Depth Received	Total Depth used in Growing Crop	Yield per Acre	Remarks
												Ft.	Ft.	Ft.	Ft.	Bus.	Cut
58A	0·0376											0·00	0·70	0·70	0·92	9·65	Sept. 23
B	0·0365		0·17									0·17	0·70	0·87	1·14	8·83	" 23
C	0·0359		0·17			0·16						0·33	0·70	1·03	0·87	11·88	" 23
D	0·0354	0·17			0·16		0·17					0·50	0·70	1·20	1·15	12·78	" 23
E	0·0311	0·17			0·16		0·17		0·16			0·66	0·70	1·36	1·04	13·63	" 23
59A	0·0343	0·17		0·16		0·17		0·16			0·17	0·83	0·70	1·53	0·94	13·65	" 23
B	0·0346	0·17		0·16		0·17		0·16		0·17	0·17						" 23
C	0·0346		0·25			0·25						0·50	0·70	1·20	1·15	13·25	" 23
D	0·0342	0·25			0·25		0·25					0·75	0·70	1·45	1·32	14·50	" 23
E	0·0300	0·25			0·25		0·25		0·25			1·00	0·70	1·70	1·57	17·71	" 23

PEAS (PRUSSIAN BLUE), 1922

Plot No. Rotation E	Area Acres	Irrigation: Date and Depth Applied in Acre-feet per Acre — June 13	June 16	June 20	June 23	June 28	June 30	July 3	July 8	July 11	July 22	July 27	August 2	August 8	August 11	Duty of Water	Rainfall April First to Harvest	Total Depth Received	Total Depth used in Growing Crop	Yield per Acre	Remarks
																Ft.	Ft.	Ft.	Ft.	Bus.	Cut
7B	.0·114															0·00	0·55	0·55	0·58	9·7	Aug. 9
6	.0·235			0·33												0·33	0·55	0·88	0·93	18·1	" 9
5	.0·233			0·33					0·34							0·67	0·59	1·26	1·33	38·0	" 26
4	.0·233	0·33					0·34				0·33					1·00	0·63	1·63	1·75	47·3	Sept. 9
3	.0·233	0·33					0·34				0·33					1·33	0·70	2·03	2·22	56·7	" 23
2	.0·232	0·33			0·34				0·33					0·34		1·67	0·70	2·37	2·38	56·8	" 23
1	.0·232	0·33			0·34			0·33		0·33		0·34		0·33		2·00	0·70	2·70	2·76	52·5	" 23
8B	.0·073		0·33	0·34		0·33			0·33		0·34		0·33	0·33		2·33	0·70	3·03	3·17	48·5	" 23
8C	.0·074		0·33	0·34		0·33			0·33		0·34		0·33	0·33	0·34	2·67	0·70	3·37	3·45	43·3	" 23
10	.0·235			0·50					0·50							1·00	0·59	1·59	1·57	39·9	Aug. 26
9	.0·231		0·50			0·50					0·50					1·50	0·63	2·13	2·19	53·5	Sept. 9
8A	.0·072	0·50				0·50					0·50		0·50			2·00	0·70	2·70	2·84	55·7	" 23
7A	.0·113	0·33			0·34				0·33			0·33		0·34		1·67	0·63	2·30	2·15	54·4	" 30

POTATOES (GOLD COIN), 1922

IRRIGATION EXPERIMENT STATION, BROOKS, ALBERTA. PLOT SERIES RECORD

Plot No. Rotation A	Area Acres	Irrigation Date and Depth Applied in Acre-feet per Acre: June 28	June	July 6	July 10	July 19	July 24	July 29	August 1	August 10	August 15	August 21	August 28	Duty of Water	Rainfall April First to Harvest	Total Depth Received	Total Depth used in Growing Crop	Yield per Acre	Remarks
														Ft.	Ft.	Ft.	Ft.	Bus.	Small p.c.
56A	0·0327													0·00	0·77	0·77	0·59	100·4	35·3
B	0·0327					0·17								0·17	0·77	0·94	0·61	147·8	12·0
C	0·0336			0·17						0·16				0·33	0·77	1·10	0·83	205·8	12·5
D	0·0338		0·17				0·16				0·17			0·50	0·77	1·27	1·09	297·7	6·7
E	0·0333		0·17			0·16				0·17			0·16	0·66	0·77	1·43	1·05	364·5	6·5
57A	0·0374		0·17		0·16				0·17		0·16		0·17	0·83	0·77	1·60	1·43	429·4	6·9
B	0·0374		0·17		0·16			0·17		0·16		0·17	0·17	1·00	0·77	1·77	1·49	425·2	4·5
C	0·0374			0·25						0·25				0·50	0·77	1·27	1·13	328·1	8·0
D	0·0374		0·25				0·25				0·25			0·75	0·77	1·52	1·16	394·6	6·0
E	0·0374		0·25			0·25				0·25			0·25	1·00	0·77	1·77	1·64	408·2	5·7
Plot No. Rotation C		June	June	June 28	July 6	July 10	July 19	July 24	July 30	August 10	August 15	August 21	August 28						
87A	0·0240													0·00	0·77	0·77	0·58	165·6	8·8
B	0·0240						0·17							0·17	0·77	0·94	0·52	179·9	3·8
C	0·0238				0·17					0·16				0·33	0·77	1·10	1·08	194·6	17·3
D	0·0358			0·17				0·16			0·17			0·50	0·77	1·27	1·33	258·2	12·1
E	0·0370			0·17			0·16			0·17			0·16	0·66	0·77	1·43	1·43	269·1	6·4
88A	0·0374			0·17		0·16			0·17		0·16		0·17	0·83	0·77	1·60	1·56	297·0	13·5
B	0·0392			0·17		0·16			0·17	0·16		0·17	0·17	1·00	0·77	1·77	1·70	295·8	11·1
C	0·0406				0·25					0·25				0·50	0·77	1·27	1·48	175·0	10·3
D	0·0420			0·25				0·25			0·25			0·75	0·77	1·52	1·37	258·5	5·2
E	0·0430			0·25			0·25			0·25			0·25	1·00	0·77	1·77	1·68	256·3	5·6

ALFALFA SEED (GRIMM), 1922

IRRIGATION EXPERIMENT STATION, BROOKS, ALBERTA. PLOT SERIES RECORD.

Plot No.	Area Acres	Irrigation Date and Depth Applied in Acre-feet per Acre: June	June 23	July 13	July 31	August 11	August 21	Duty of Water	Rainfall April First to Harvest	Total Depth Received	Total Depth used in Growing Crop	Yield per Acre	Remarks
								Ft.	Ft.	Ft.	Ft.	Bus.	Cut
102A	0·0553		0·33					0·33	0·59	0·92	1·40	3·5	Aug. 29
B	0·0585		0·33					0·33	0·59	0·92	1·11	0·9	" 29
C	0·0583		0·33	0·25				0·58	0·59	1·17	1·38	4·4	" 29
D	0·0690		0·33	0·25	0·25			0·83	0·70	1·53	1·82	7·2	Sept. 27
E	0·0690		0·33	0·25	0·25	0·25		1·08	0·70	1·78	2·04	8·7	" 27
F	0·0700		0·33	0·25	0·25	0·25	0·25	1·33	0·70	2·03	2·27	11·9	" 27
		June	June 24	July 14	July 31	August 11	August 21						
107A								0·00	0·59	0·59	0·92	0·00	
B	0·0430		0·25					0·25	0·59	0·84	1·21	0·8	Aug. 29
C	0·0576		0·25	0·25				0·50	0·59	1·09	1·44	1·21	" 29
D	0·0620		0·25	0·25	0·25			0·75	0·70	1·45	1·56	2·98	Sept. 27
E	0·0630		0·25	0·25	0·25	0·25		1·00	0·70	1·70	1·83	6·47	" 27
F	0·0563		0·25	0·25	0·25	0·25	0·25	1·25	0·70	1·95	2·08	1·92	" 27

DUTY OF WATER MEASUREMENTS ON FARMS IN COALDALE DISTRICT

Irrigation investigations in the Coaldale district were carried out along the same lines during 1922 as were adopted in previous years. The season's work was begun by C. B. McAllister on April 6, but the whole month was so cold and stormy, that it was impossible to do any appreciable amount of repair work on the measuring structures until after May 1.

The most severe blizzard experienced in this part of the province in many years occurred on April 8, a fall of eight and one-half inches of snow being

recorded. This storm made the roads very heavy and was followed by several other storms during the month.

Old structures were repaired, and new structures placed on tracts numbered 305, 307, 324, 316, 310 and 330.

The entire stand of alfalfa on tract 310 was winter-killed, and the tract was abandoned for experimental purposes. Tracts 308, 309 and 331 were not irrigated, and no data are available from them. Tract 327 was so damaged by cutworms and grasshoppers, and so badly irrigated, that the data secured from the irrigation measurements were considered unreliable, and discarded.

The mean temperature, April to September, was 56·8° as compared with 55·4° for 1921, and 54·7° for 1920. This past season was slightly warmer than any since 1914. The evaporation for the same period was 26·73 inches.

The table immediately following gives a summary of the duty of water data obtained during the season. Alfalfa tracts 305, 312, 314, and 329 received but one irrigation, the other five alfalfa tracts received two irrigations.

No field yielded more than two cuttings. Tract 324 produced the heaviest first cutting, 3·35 tons per acre, and also produced the heaviest total yield, 4·59 tons per acre, for the two cuttings. This yield was produced with a total depth received of 2·02 feet, of which 1·35 feet was applied in two irrigations.

For the eleven fields in forage crops during 1922, the average total depth of water received was 1·72 feet, and for the four fields in grain crops, the average total depth of water received was 1·15 feet. For all tracts the average total depth received was 1·57 feet, of which 0·90 foot was received as irrigation.

DUTY OF WATER TRACTS, COALDALE, ALBERTA, 1922

Plot No.	Acres	Irrigation					Acre-feet per Acre								Yield		Crop	Remarks
		No.	Began	Ended	Duration in Hours	Average Head C.F.S.	Supplied	Wasted	Used	Used per Acre	Duty	Rainfall April to Harvest	Total Depth Received	Total Depth Used	Tons Per Cutting	Tons Per Acre		
302	30·00	1	June 14	June 29	302	2·13	53·44	9·04	44·40	1·48	....	....	....	....	1·30	....	....	First irrigation too heavy.
		2	July 29	Aug. 29	201	1·69	28·18	8·58	19·60	0·65	2·13	0·69	2·82	3·13	0·55	1·85	Alfalfa	
304	42·00	1	May 27	June 4	201	1·32	21·94	1·40	20·54	0·49	....	....	....	....	1·22	....	"	
		2	July 27	Aug. 8	201	1·57	37·73	10·36	27·37	0·65	1·14	0·67	1·81	1·47	1·17	2·39		
															1·99			Late and insufficient irrigat'n.
305	23·50	1	July 23	July 28	126	2·85	29·80	13·65	16·15	0·69	0·69	0·67	1·36	1·70	1·26	3·25	"	
306	14·00	1	June 17	June 20	65	0·84	4·50	3·06	1·44	0·10	....	....	....	....	1·48	....	"	Irrigation too late.
		2	July 19	July 23	90	2·71	20·24	6·38	13·86	0·99	1·09	0·69	1·78	0·96	1·10	2·58		
															2·38			
312	50·00	1	July 24	July 31	116	2·45	33·70	....	33·70	0·67	0·67	0·69	1·36	1·31	1·17	3·55	"	
															2·67			
314	35·09	1	July 24	Aug. 4	258	2·78	60·14	....	60·14	1·71	1·71	0·67	2·38	2·68	1·64	4·31	"	
		1	June 13	June 22	189	1·63	25·53	....	25·53	0·51	....	....	....	....	2·84	....	"	
315	50·00	2	July 22	July 28	148	1·18	14·71	....	14·71	0·29	0·80	0·67	1·47	1·37	1·42	4·26		
		1	June 2	June 12	226	1·06	19·98	3·50	16·48	0·50	....	....	....	....	3·35	....	"	
324	32·73	2	Aug. 3	Aug. 13	246	1·52	31·12	3·30	27·82	0·85	1·35	0·67	2·02	1·83	1·24	4·59		
															1·73		"	
329	11·00	1	July 15	July 19	106	1·39	12·19	1·21	10·98	0·99	0·99	0·69	1·68	1·94	2·50	4·23		
		1	May 21	May 28	154	1·03	13·32	5·66	7·66	0·34	....	....	....	....		....		
303	22·5	2	June 11	June 15	85	1·09	7·68	2·92	4·76	0·22	0·56	0·65	1·21	1·30	1·38	1·38	Timothy	
332	50·0	1	June 8	June 22	340	0·67	19·23	....	19·23	0·38	0·38	0·65	1·03	1·37	0·94	0·94	"	
					Average for all forage crops						1·05	0·67	1·72	1·73				
															Bus	hels		
316	53·50	1	July 3	July 8	113	1·93	18·10	5·92	12·18	0·23	0·23	0·67	0·90	0·37	....	22·4	Wheat	
322	13·00	1	July 24	July 29	127	1·12	11·82	....	11·82	0·91	0·91	0·67	1·58	1·37	....	11·9	Barley	
326	43·94	1	June 24	July 20	81	2·37	15·99	....	15·99	0·36	0·36	0·67	1·03	0·89	....	16·4	Wheat	
330	40·56	1	July 8	July 15	170	1·19	16·89	....	16·89	0·42	0·42	0·67	1·09	1·02	....	33·3	"	
					Average for grain tracts						0·48	0·67	1·15	0·91				
					Average for all tracts						0·90	0·67	1·57	1·52				

DEPTH OF WATER USED ON COALDALE TRACTS, 1913-22

Crop	(1913)			(1914)			(1915)		
	Duty	Precipitation	Total Depth Received	Duty	Precipitation	Total Depth Received	Duty	Precipitation	Total Depth Received
Alfalfa	1·70	0·98	2·68	2·11	0·57	2·68	0·68	1·32	2·00
Timothy	0·85	0·98	1·83	....	....	....	1·28	1·32	2·60
Wheat	0·74	0·98	1·72	....	....	....	0·22	1·32	1·54
Barley	....	....	....	1·25	0·57	1·82	0·00	1·32	1·32
Oats	....	....	....	1·49	0·57	2·06	0·00	1·32	1·32
Average for all tracts	1·15	0·98	2·13	1·84	0·57	2·41	0·57	1·32	1·89
——	(1916)			(1917)			(1918)		
Alfalfa	0·41	1·56	1·97	1·31	0·68	1·99	2·00	0·31	2·31
Timothy	0·33	1·56	1·89	1·48	0·71	2·19	1·30	0·30	1·60
Wheat	0·00	1·73	1·73	0·78	0·41	1·19	1·16	0·29	1·45
Barley	0·00	1·56	1·56	....	....	....	....	....	....
Oats	0·00	1·73	1·73	....	....	....	1·04	0·28	1·32
Average for all tracts	0·28	1·56	1·84	1·18	0·65	1·83	1·70	0·30	2·00
	(1919)			(1920)			(1921)		
Alfalfa	1·66	0·47	2·13	1·31	0·81	2·12	1·59	0·46	2·05
Timothy	1·25	0·25	1·50	0·80	0·78	1·58	0·35	0·36	0·71
Wheat	1·18	0·38	1·56	0·47	0·81	1·28	0·86	0·48	1·34
Barley	....	....	....	....	....	....	....	....	....
Oats	1·15	0·42	1·57	0·55	0·80	1·35	0·70	0·43	1·13
Average for all tracts	1·33	0·43	1·76	1·11	0·81	1·92	1·30	0·45	1·75
	(1922)			Average (1913-1922)			Number of Fields		
Alfalfa	1·18	0·41	1·85	1·39	0·76	2·18	90		
Timothy	0·47	0·36	1·12	0·94	0·72	1·69	14		
Wheat	0·33	0·31	1·01	0·73	0·74	1·52	29		
Barley	0·91	0·29	1·58	0·31	0·93	1·39	7		
Oats	....	....	....	0·80	0·79	1·59	15		
Average for all tracts	0·90	0·67	1·57	1·14	0·77	1·91	Total Fields...155		

The preceding table shows the average total depth of water received—irrigation plus precipitation—for the Coaldale tracts from 1913 to 1922 inclusive, a ten-year record. The average total depth of water received for the grain crops weighted in accordance with the number of tests on each crop, is 1·52 feet; the average depth applied or duty is 0·78 foot.

For the alfalfa and grasses the average total depth received is 2·11 feet; the average depth applied 0·75 foot.

For all plots, alfalfa, grasses and grains, the average total depth received is 1·91 feet; the average depth applied 0·77 foot.

DISCUSSION OF SUMMARIZED DATA

The duty of water for any locality will vary from year to year, principally in accordance with the amount and seasonable distribution of the precipitation, and to a lesser extent as influenced by temperature and the condition of soil and subsoil; therefore, in order that the water requirements of crops may be readily compared, from one year to another, or between different localities, it is best to consider that crops annually receive a certain amount of water—precipitation plus irrigation—and designate this amount as the "Total Depth Received."

The following table gives a summary of the data collected from the Coaldale, Ronalane, and Brooks stations during the period 1913 to 1922 inclusive. It is not intended to set forth these figures as representing the exact depths required for the various crops, but rather as showing the results of our investigations to date. The column headed "Yield" is inserted as a useful index to the crops produced at these three stations. The column headed "Depth" shows in feet the total depth of water received (irrigation plus precipitation).

The *average depth* shown is the average of the depths at the different stations weighted according to the number of years during which records have been taken at each place. The column marked "Average Depth" shows the average for Coaldale, Ronalane and Brooks.

The data at Coaldale are based on the results gained by average farmers irrigating their own fields and cover a period of ten years,—the yields at Coaldale have been omitted because they would not be comparable with the results obtained at the other places.

The results at Ronalane are based on plot work carried on continuously for six years. The results at Brooks are based on accurate and consistent plot work covering a period of five years. For Ronalane and Brooks the figures shown represent the average, at each place, of the total depths of water producing the maximum crop yield in each year. For Coaldale the figures represent the average for ordinary crops in each year.

SUMMARY OF DATA COLLECTED, 1912-22 (Inclusive)

Crop	Coaldale		Ronalane		Brooks		Average Depth
	Yield	Depth	Yield	Depth	Yield	Depth	
Wheat	....	1·37	45·90	1·91	47·30	2·04	1·70
Oats	....	1·52	91·40	2·15	104·30	1·92	1·84
Barley	....	1·61	58·50	1·74	55·10	1·89	1·81
Peas	....	....	44·00	2·31	56·20	2·33	2·32
Potatoes	....	0·83	371·00	2·03	322·00	1·68	1·76
Flax	....	....	....	....	26·00	2·03	2·03
Alfalfa seed	....	....	....	....	9·20	1·51	1·51
Alfalfa	....	2·13	3·32	2·13	6·18	2·78	2·21
Grasses	....	1·85	....	....	2·01	1·78	1·83
Sugar beets	....	....	1·35	1·66	16·20	1·82	1·71

The average depth noted in the above table indicates quite clearly the total depths required for the crops listed, when grown in that part of Alberta lying south of the north boundary of townships 28, and exclusive of that strip of country lying immediately east of the foothills.

The mean summer precipitation for the past six dry years 1917 to 1922 inclusive, was:—

Ronalane	0·51 foot
Brooks	0·57 "
Coaldale	0·64 "
Mean of 3 stations	0·57 "

We find, therefore, that even during the past six dry seasons in southern Alberta we have had enough precipitation when added to the legal duty, to produce all the moisture required for any crop.

Assuming, as in previous reports, that eventually all irrigated farms will be seeded down, one-half to alfalfa and one-half to common grasses, we have:—

Average depth for wheat, oats and barley	1·78 feet
" " alfalfa	2·21 "
Total required for entire farm unit	2·00 "

With the legal duty at 1·5 feet, under these conditions it would be necessary to rely on the seasonal precipitation to make up the additional 0·5 foot.

COMPARISON OF CLIMATIC CONDITIONS IN ALBERTA

	Precipitation									Temperature								
	1914	1915	1916	1917	1918	1919	1920	1921	1922	1914	1915	1916	1917	1918	1919	1920	1921	1922
	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	°F	°F	°F	°F	°F	°F	°F	°F	°F
Strathmore	0·71	1·44	1·33	0·85	0·48	1·09	0·74	0·75	0·83	52·4	52·6	50·6	52·0	52·8	52·9	51·0	52·6	52·9
Ronalane	0·38	0·93	1·32	0·50	0·38	0·57	0·45	0·56	0·60	59·4	57·1	55·2	55·8	56·8	58·4	56·0	57·5	58·7
Coaldale	0·57	1·32	1·56	0·72	0·37	0·64	0·84	0·55	0·73	55·9	55·4	54·5	55·4	55·9	56·7	54·7	55·4	56·8
Brooks	....	....	....	0·57	0·32	0·70	0·41	0·69	0·70	55·6	56·3	....	56·3	58·0	57·5	55·6	56·1	57·4

	Precipitation		Temperature	
	1914–1922	Long Term	1914–1922	Long Term
	Feet	Feet	°F	°F
Calgary[1]	0·77	1·00	54·37	52·57
Medicine Hat	0·72	0·77	59·31	59·07
Lethbridge	0·80	0·96	54·83	55·63

[1]Calgary—index for Strathmore—long term records 1885–1922. Medicine Hat—index for Ronalane and Brooks—long term records 1884–1922. Lethbridge—index for Coaldale—long term records 1903–1922..

DIAGRAM SHOWING TYPICAL SOILS OF

—	Strathmore	Ronalane	Coaldale	Brooks
	Sandy Soil Fine	Fine Sandy Loam Soil	Clay Loam	Fine Sandy Loam
First Foot	Sandy Soil to depth		Light Clay Loam	Very uniform
Second Foot	varying from	Sandy Loam	very uniform	soil. Very fine sand
Third Foot	3 to 7 feet		has no	and silt Light
Fourth Foot	Heavy clay and gumbo	Sand and	impervious stratum	gravel at 12 to 14
Fifth Foot	subsoil Very	Gravel		feet depth
Sixth Foot	impervious			

REPORT OF THE SUPERVISING HYDRAULIC ENGINEER OF THE DRAINAGE DIVISION, J. S. TEMPEST, M.E.I.C.

During the fiscal year 1922-23 drainage inspections, investigations and construction were carried on in Alberta, Saskatchewan and Manitoba by the Drainage Division of the Reclamation Service as shown in the following schedule:—

Project	Class of Work	Engineer
ALBERTA		
Athabaska	Location survey	G. F. Richan.
Private schemes, 61	Investigating surveys and plans	D. Whittaker.
Provincial schemes, 9	Inspections	D. Whittaker.
SASKATCHEWAN		
Carrot River Triangle (West)	Location survey	G. F. Horsey and W. C. Warren.
Waterhen Lake	Construction	A. C. Wright.
Private schemes, 2	Surveys and plans	A. C. Wright.
Private schemes, 4	Surveys and plans	D. Whittaker.
Provincial schemes, 3	Inspections	D. Whittaker.
MANITOBA		
Carrot River Triangle (East)	Location survey	G. F. Horsey and W. C. Warren.

The reclamation of submerged and wet lands has long been recognized as a highly remunerative investment, and the reclaimed lands on account of their accumulation of rich vegetable matter are usually richer in plant food, and of more lasting fertility than the surrounding higher lands. Before the passing of the Reclamation Acts of Alberta and Saskatchewan very little progress was made in reclamation by drainage in these provinces owing to the meagre and inefficient legislation. The Acts have now been in force for about six years, and this period has been marked by a growing interest in drainage and a better understanding of its possibilities as an economic investment. Drainage projects investigated are of three classes,—(1) small schemes undertaken by individuals, generally settlers with a view to raising more winter feed for their stock; (2) schemes undertaken by the Provincial Governments, to enable groups of settlers to co-operate in carrying out comprehensive drainage schemes for the improvement of their own lands and any Crown lands in the drainage district; and (3) schemes initiated by the Dominion Government for the reclamation of large tracts of swamp lands where upwards of 50 per cent of the land is owned by the Crown. Schemes in classes (1) and (3) are generally situated in the more northern parts of the provinces, where the prevalence of wet lands, swamps, muskegs and shallow lakes is more marked, and where settlement is sparse. The investigation of these schemes constitutes the principal work of the Drainage Division in surveying, designing, laying out the schemes, and in one instance, the Waterhen Lake Drainage project, of carrying out the construction. Schemes in class (2) are carried out under the jurisdiction of the provincial governments after being inspected and sanctioned by the Dominion Government.

The efforts of the engineers of the Drainage Division have not been confined merely to the engineering requirements of surveying, making plans and supervising construction of the various projects, but much time and study has been given to the most economical methods of bringing the areas under cultivation after drainage, which in many cases involves the most difficult and uncertain part of reclamation. The ever varying conditions of the extensive muskegs, swamps, beaver meadows and wet grass lands, spreading over a great proportion of the northern parts of the prairie provinces, present many reclamation problems at present but little understood. The great potential agricultural value of the land, however, is sufficient to warrant careful and extensive research. In a pioneer country where the cost of artificial manures for the improvement of peat lands and systems of underdraining are prohibitive, the scientific investigations being carried on at many experimental farms, involving as they do the application of chemical or barnyard manures, are of little practical value to the settler in a new country. For the present, systematic firing to rid the ground of superfluous vegetable matter, the trampling of herds of cattle to compact the light vegetable soil, and the flooding of wild hay meadows by means of hold-up gates after the installation of a system of drainage, are among the principal methods practicable in a new country. The only active and practical experimentation on these lines is carried on by the settler, who is often forced by necessity to drain and reclaim swamp lands or leave the country. With these pioneers the inspecting drainage engineer is working in an endeavour to devise the readiest and most economical methods within the means of the settler to convert the wilderness of the north into profitable farming lands. The greater interest shown in drainage and the increased number of applications in certain districts is, to a large extent, due to the practical demonstration of enterprising settlers who have acquired and converted lakes and swamp lands into profitable hay meadows and farming land at a very small cost per acre. Examples are becoming more and more common of reclaimed lands growing from 2½ to 4 tons of timothy to the acre from the first season the water is drained off, while green feed often grows so thick, that there is difficulty in cutting it with a binder. It is very significant, that small projects carried out under the provisions of Part I of the Regulations appear on the map in clusters, owing

to the fact that one successful scheme in a district is commonly followed by a number of applications to purchase other swamp lands under conditions of drainage.

The successful development of a large portion of the north country is largely dependent upon the amount of drainage carried out. Generally speaking the northern parts of Manitoba, Saskatchewan and Alberta consist largely of swamp lands with only straggling and intermittent dry areas fit for settlement. Wet conditions delay the spring work on the farm, make the country more liable to summer frosts, and generally shorten the growing season. The people of the north commonly believe that drainage is the only salvation of the country. Every successful drainage scheme is a benefit, not only to the applicant and to the district in which it is situated but by making better roads possible at a smaller cost, indirectly benefits other outlying farming communities.

No new large drainage projects under Part IV of the Drainage Regulations were investigated during the season, but an attempt was made to complete the surveys of all those already commenced. This work was entirely confined to the Athabaska project in Alberta and the Carrot River Triangle project in Saskatchewan and Manitoba. The field investigations of the former were completed, but another season will be required to complete the latter.

Since the formation of the Drainage Division, 34 large projects have been investigated. Of these only 13, aggregating about 269,000 acres, have been favourably reported on as feasible, economical and in the public interest. One of these, the Waterhen Lake project, is now under construction, while plans are ready for commencing construction of the rest.

ATHABASKA DRAINAGE PROJECT

This project lies a few miles east of the town of Athabaska between the Athabaska river and its tributary, Pine creek, in townships 65 to 68, ranges 19 to 22, west of the 4th meridian. Although the Canadian National railway from Edmonton to Athabaska has been constructed twelve or fifteen years, and is within a few miles of the land included in the project, settlement of the district is little further advanced than it was ten years ago. Some settlers who took up land in the district abandoned their homesteads and left the country, being unable to succeed on account of the wet conditions, and the impassable nature of the roads during the open season. The population of the town of Athabaska has dwindled from 2,000 to 200 during the last ten years, but this is largely owing to the traffic to the north being diverted by the construction of the Edmonton, Dunvegan, and British Columbia railway to the Peace River and the Alberta and Great Waterways railway to Fort McMurray. Had the country surrounding Athabaska developed agriculturally, the town would not have suffered as it has, notwithstanding the diversion of the traffic. The prevailing wet conditions not only prevent further agricultural development, but cut off communication with, and prevent settlement of dry areas of good agricultural land lying east of the Athabaska muskegs.

With a desire to bring prosperity to the town and district, and develop a country of naturally rich soil and good climate, the Athabaska Board of Trade and many interested settlers petitioned the Federal Government to undertake the reclamation of the swamp lands under the provisions of Part IV of the Drainage Regulations, and so give an impetus to agricultural progress, and attract settlers to a district of proved fertility of soil and convenient railway facilities.

A reconnaissance made in 1921 resulted in a favourable report, and a recommendation that a detailed location survey should be made. A survey party occupied the season of 1922 in making a complete survey. The engineer reports that the project, comprising a total area of 46,800 acres of reclaimable land can be drained at an average cost of less than $4 per acre.

While the area drained would be reclaimed from a worthless and impassable series of bogs, a rich and extensive agricultural district lying beyond the proposed drainage district would be made accessible by the construction of good roads hitherto impossible.

The plan of reclamation proposed consists of twenty individual systems; three draining into Athabaska river and the remainder into Pine creek, the majority of the latter being comparatively small single ditches. The system would tap and provide an outlet for each parcel of land requiring drainage, leaving the owner to put in any farm laterals required to drain his holding to the main ditch. The improvement of Pine creek necessary to prevent an increase of flood conditions would require only the removal of the debris collected at several points. The total length of ditch required, including laterals and creek improvements aggregates about 135 miles.

After drainage it might be found advisable and more economical to continue growing wild hay on the extensive hay meadows for a few years at least. As wild hay requires periodic flooding, it is proposed to put in hold-up gates at suitable points in the drainage ditches. By these means, water could be held back in the spring to ensure a good growth of hay, then drained off in time to dry up the meadow sufficiently to permit the cutting of the hay. Other areas covered with moss, reeds, and scrub timber would require to be burnt over to get rid of the surplus vegetable matter, and it is proposed to have this work done under efficient supervision to prevent the fires spreading to the timber on the ridges, which will be required for buildings, fencing and fire wood.

A great portion of the work of reclamation on this project can be economically carried out by manual labour, and would afford profitable employment to prospective settlers, while the land is being made suitable for settlement and cultivation.

CARROT RIVER TRIANGLE DRAINAGE PROJECT

The Carrot River Triangle is a triangular tract of extremely flat swamp land situated in the provinces of Saskatchewan and Manitoba, and bounded on the north by the Saskatchewan river, on the south by the Carrot river, and on the west by the Sipanok channel—an overflow channel of the Saskatchewan river. The apex of the triangle is at the junction of the Saskatchewan and Carrot rivers near the town of The Pas, in Manitoba. The tract comprises an area of 695,168 acres, or 1,086 square miles, with a further 350 square miles in the Pasquia extension of the swamp. The aggregate area is about 1,436 square miles.

The climate is similar to that of the settled agricultural district in the upper Carrot river valley around Kinistino, Melfort and Prince Albert, with possibly a greater liability at present to summer frosts and a later spring, on account of the prevailing wet and swampy conditions.

The soil is the same rich black muck overlying clay and clay loam that characterizes the fertile upper part of the Carrot River valley.

Transportation facilities at present consist of the Canadian National railway touching the eastern extremity of the triangle at The Pas, which is 400 miles by rail from Winnipeg, and 440 miles by the extension of this road to Port Nelson on the Hudson Bay,which is not yet completed. From The Pas both the Saskatchewan and Carrot rivers are navigable for boats of small draft to the northwestern and southwestern extremities of the triangle. No part of the tract is more than 16 miles from either one or the other of these navigable streams. Surveys have been made both by the Canadian National and Canadian Pacific Railways with a view to extending lines to Cumberland House, and eventually to The Pas through the triangle, and it is expected that the reclamation would very materially facilitate and lessen the cost of these railway extensions.

The timber in the eastern or Manitoba portion of the triangle is small and of no commercial value, but farther west in Saskatchewan, belts of fine spruce and other timber extend along the banks of the streams.

After drainage very little expense and labour will be necessary to bring under cultivation or convert into profitable hay meadows the greater part of the area lying in Manitoba and consisting of several hundred square miles. This portion consists largely of Saskeram and other lakes, the beds of which are so bare of reeds, rushes and grasses as to be ready for seeding to cultivated grasses as soon as the water has been drained off. The rest of the area in Manitoba consists mostly of luxuriant hay meadows.

In Saskatchewan, although there are many shallow lakes bare of vegetation, and considerable stretches of hay meadows, there is a large proportion of moss muskegs, stretches of reeds, rushes and scrub timber that will require considerable clearing after the water is drained off, and therefore will not be reclaimed as economically as the Manitoba portion.

The method of reclamation will consist in the construction of levees along the banks of the Saskatchewan and Carrot rivers to keep out the flood waters, and of a system of interior drainage ditches to carry the run-off of the triangle to sumps, and thence to be pumped over dykes into these two streams.

Until the surveys are completed, and several plans of reclamation considered and compared, the cost of the project or units of the project can only be roughly estimated. Two schemes of reclamation are being considered. In scheme "A" the reclamation of the whole area is contemplated. The triangle would be divided into five drainage units each with its protective levees and system of ditches conveying the drainage water to the most convenient point to be pumped into either the Saskatchewan or the Carrot rivers. It is roughly estimated that this scheme would involve an expenditure of $6,077,000 to reclaim 695,168 acres of land, or an average cost of $8.74 per acre.

Scheme "B" contemplates only the reclamation of the eastern or Manitoba end of the triangle, and cutting off this area from the rest of the tract by a levee extending from the Carrot to the Saskatchewan. It is roughly estimated that this scheme would cost $2,112,000 to reclaim 163,456 acres, or an average of $12.92 per acre.

WATERHEN LAKE DRAINAGE PROJECT

This project, comprising 13,900 acres, is situated in the Carrot River valley about four miles from the town of Kinistino, Saskatchewan, in townships 44, 45 and 45A, ranges 21 and 22, west of the 2nd meridian. The area being reclaimed consists of Waterhen lake and Waterhen marsh; two distinct bodies of submerged land each draining into the Carrot river and of about equal area.

The drainage of this project was undertaken by the Dominion Government and a drainage district was formed in 1920 under the provincial laws.

A contract for the excavation of the main ditches, aggregating about 617,000 cubic yards of earth, was let to the Lount Engineering Company at 21·9 cents per cubic yard. This work was commenced in the spring of 1921, and completed in the fall of 1922. Two draglines with 2-yard buckets, one floating dredge with $1\frac{1}{4}$-yard bucket, and one caterpillar dragline with 1-yard bucket were used on the work.

The water of the lake was tapped on July 13, 1922, and was completely drained by August 14, the same year. By means of a hold-up gate at the outlet, the discharge was controlled so as to keep it below the maximum flow of previous years.

After unwatering, the lake bed began to dry very quickly where there was no vegetation and matted roots, and by September it was possible to walk dryshod over the greater part. The marsh and the parts of the lake covered by rushes and coarse grasses are drying very slowly. The additional laterals, that

are about to be constructed, will help to expedite the drying up of these parts very materially. On account of the drier conditions, a larger quantity of wild hay was cut than ever before, both on the lake and on the marsh.

About half the lake bed, comprising about 3,000 acres, is now ready for seeding to timothy or other cultivated grasses. The best time—and a common practice in the West, for seeding drained lake beds—is as soon as the water has been run off, and whilst the ground is soft mud. As the ground is too soft to permit the use of teams, the seeding has to be done broadcast. It is possible that seeding will now have to be deferred until the ground is firm enough to permit the use of machinery. To complete the works of the project there yet remains to be constructed about 10,000 rods of small laterals, a number of culverts at road crossings, six bridges, right of way fencing, and topping of levees.

SMALL DRAINAGE PROJECTS

During the season 77 private drainage schemes coming under the provisions of Part I of the Drainage Regulations were inspected. At the present time there are about 15,000 acres of low lands included in these small private schemes being brought under cultivation, and about 20 per cent reclaimed and under crop. The average cost of this reclamation is from $5 to $8 per acre. During the year approximately 1,200 tons of wild hay and 1,060 tons of timothy were produced in Alberta on reclaimed swamp lands in these small projects.

The locations of small drainage projects are in groups. The development of these groups has come about by the success of a drainage pioneer in a certain district whose methods and example were immediately followed by his neighbours.

The group lying southeast of Edmonton originated in the success of Mr. Burpee, followed by Messrs. Cameron, Charest and others, numbering about twenty. Many of these schemes are producing up to four tons of timothy to the acre.

Another group is situated around Westlock, ranges 26 and 27, west 4th meridian, and ranges 1 and 2, west 5th meridian, in townships 55 to 59. This group was started by the success of Messrs Demers and Son, who reclaimed a shallow lake near Pickardville. Another group in a totally different and more difficult country was started by the success of Messrs. Hedberg, Gibbs, Strome and others in the neighbourhood of Edson.

RECLAMATION SERVICE

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